THE UNIVERSITY OF ALBERTA

MDES FINAL VISUAL PRESENTATION

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF DESIGN

IN

INDUSTRIAL DESIGN

DEPARTMENT OF ART AND DESIGN

EDMONTON, ALBERTA

WINTER 2003

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled:

Final Visual Presentation

submitted by TIMOTHY NEIL ANTONIUK partial fulfilment of the requirements for the degree of Master of Design.

The University of Alberta

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THESIS DEGREE FOR WHICH THESIS WAS GRANTED MASTER OF DESIGN

YEAR THIS DEGREE WAS GRANTED 2003

DESIGNER'S STATEMENT

Everything is designed. Good, bad, desirable or disabling, design surrounds us throughout every moment of our life. It has the ability to influence actions, shape lives, alter global economics, and even improve (or worsen) the world's ecology.

Upon starting my Masters degree, my initial research focused strictly on innovations in materials and processes in the contemporary furniture design industry. After a number of months I realized that I was attempting to create desire, like most businesses today, through a centuries old approach to form and material ornamentation. This stagnant approach to the design of products began to reveal a strange and poignant dichotomy between the practical issues that business faces (which tend for focus specifically on its' own *economic* well-being), and the more theoretical concerns (which I consider to be *social* and *ecological* issues) that most businesses fail to appropriately and consistently address.

Although every design studio has their own approach to the strategic development of an artifact, and to their corporate manifesto, I feel that one of the greatest causes of our degrading *social, economic and ecological* situations is a deep seeded reliance on an old and narrow information band. Typically, this information (which relates to epistemology, or the study of knowledge) is focused strictly on short to mid-term economic prosperity. There is little or no daily commitment to the ethics that surround social and ecological conditions. For me, this suggests that designer's have an opportunity, and perhaps even a responsibility, to reconsider the impact of their decisions and how they can positively, or adversely, affect people and systems beyond the physical use of an artifact.

I hope that the select pieces of furniture that I have displayed, inspire, give pleasure, and begin to answer some of the larger issues of my thesis work.

Tim Antoniuk

"Materialism: reconsidering consumption and production patterns"

The design and fabrication of a line of contemporary furniture using a revised design methodology that emphasizes ethics and an evolving knowledge base as means of guiding the selection and use of materials and manufacturing processes.

February 2003

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A support document in partial fulfillment of the Masters of Design degree.

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Dedication

This thesis is dedicated to my family, Susan, Noah, Joshua and Ryan.

Acknowledgements

This thesis and the ideas that I propose would not have been possible without the help of a small but very important group of people. First, I would like to thank my advisor, Robert Lederer, for granting me so much freedom to explore, and in providing me with a tremendous amount of support from areas and people within the Industrial Design program. Jorge Frascara for being such a marvelous role model by practicing, teaching and discussing with me, critical and contemporary issues in the design world. The Chair of Art and Design, Jetske Sybesma, for supporting and saying so many kind words about my current and previous work. Steve Bell for being such an exceptional office partner and for all of the thought provoking conversations that we had throughout the year. Ken Horne, Craig LeBlanc and Cam Frith for their friendships and support in the shop. And, all of the people that I have met in the furniture design industry over the years that have kept me excited about this industry and its ability to make a difference in people's lives.

Contents

Abstract

This paper addresses ethics and epistemology in the materials and processes specification stage of the furniture design process. Working within a design framework that focuses on the entire product and its "life-cycle system", critical emphasis has been placed on accessing current and accurate information, and in the interpretation and application of this knowledge. Following this methodology, a diverse line of contemporary furniture was created that incorporates attractive, innovative, eco-efficient and eco-effective materials and manufacture methods, while respecting and improving the balance between three distinct yet interdependent areas that the design of an artifact affects: social, economic, and ecological conditions.

1. Context – Understanding today's international contemporary furniture design industry

1.1 Current trends in the furniture design industry

During the later part 20th century, many sectors of the furniture design and fabrication industry began to recognize a need for change. Stagnant sales, increased competition and a growing concern with social and environmental issues encouraged many companies to reconsider their strategic approach to selling and manufacturing goods and services. In the late 1990s, a multi-national furniture manufacturing company located in California, called *Herman Miller,* began to actively assess and alter their dated approach to manufacturing. Research findings concluded that traditional cost-cutting tactics in the areas related to waste disposal and poor employee work environments, were adversely affecting the company's bottom-line. As a testament to this insight, a new factory was built around a strategic approach to the design and fabrication of its goods and services. Evolutionary principals such as: improving employee morale, creating a greater sense of well-being, and reducing waste of all kinds were integrated at all levels of the fabrication and supply chain. As stated in the video, *The Next Industrial Revolution, the birth of a sustainable economy,* worker productivity doubled at *Herman Miller*, energy costs were reduced by 30%, employee attendance improved and waste was substantially reduced (McDonough, Braungart Video, 34 mins).

Formica Corporation, a finished wood supplier, began to address equally important issues that related to the abuse and neglect of "natural capital"[1]. In an effort to better manage its waste, productivity and ecological impact, a new strategy was implemented in the mid 1990s that allowed them to better manage their actions in a direct manner. For

[1] "Natural capital (also called natural resources, or common goods) includes all the familiar resources used by man kind: water, minerals, oil, trees, fish, soil, air, et cetera. But it also encompasses living systems, which include grasslands, savannas, wetlands, estuaries, oceans, coral reefs, riparian corridors, tundras, and rain forests." (Hawkins, et al. 2)

example, *Formica Corporation* has reduced their paper consumption by 80,000 cubic yards per year by altering one production process. They have eliminated the use of all heavy metals, have moved to the use of water-based resins, and are able to compost 80% of the solid waste that they generate. These significant actions forced *Formica Corporation* to live in the present, but to consider the long-term consequences of any action, such as destroying the local ecosystem, taking responsibility for the health of the people that use and make their products, and ensuring growth and prosperity for their shareholders through innovative cost-cutting actions.

Although *Herman Miller* and *Formica Corporation* have been taking many steps to correct their previous misdoings, this type of unsolicited business action does not reflect common business practice in this, or other related industries. To address this problematic situation, local, national, and certain international governments and organizations have been instituting new regulatory laws, penalizing industries which fail to comply with new higher standards of factory emissions, creation of waste, and material toxicity. This in turn, raises a very simple question: if so many improvements have been occurring throughout the 20th century, why are we starting to see "decline(s) in every living system in the world?" (Hawken, et al 4). The answer to this challenging question, though complex to resolve and difficult to act on, is threefold. First and foremost, it is due to the massive increase in consumption per person, and in the number of people that are consuming goods and services (Kluger, Dorfman 34-35). Second, it has been due to industries' lack of understanding and ethical investigation into the harmful materials our artifacts are produced with, the methods in which they are manufactured, and how the material decomposition "plan" was designed for integration with Nature's complex ecological system. Third, a socially and ecologically destructive paradox has developed between government's desire to gain short-term economic growth through industry expansion and their obligation to "Protecting the People". This short-term focus and shift towards protecting business has begun to sacrifice the long-term health and prosperity of most social and ecosystems. According to Hawken, "We have reached a point where the

value we do add to our economy is now being outweighed by the value we are removing, not only from future generations in terms of diminishing resources, but from ourselves in terms of unlivable cities, deadening jobs, deteriorating health, and rising crime. In biological terms, we have become a parasite and are devouring our host" (126).

As Hawken, and host of other business people/authors note, the design and fabrication industries around the world (including the contemporary furniture industry) have had a very tenuous relationship with the environment, with the people that they affect, and with a legitimate desire for continued economic growth. In order to better understand the contemporary furniture industry's rationale, one must look at questions of ethics and epistemology.

1.2 Furniture, ethics and epistemology

Heylighen believes that epistemology "attempts to answer the basic question: what distinguishes true (adequate) knowledge from false (inadequate) knowledge? Practically, this question translates into issues of scientific methodology: how can one develop theories or models that are better than competing theories?" (Epistemology ¶).

This definition of epistemology highlights, and brings into question, an important consideration that must be addressed in any ongoing design process: designers must recognize that knowledge is an evolutionary phenomenon that occurs throughout every person's and business' life. It is considered to be an additive process that results from the accumulation and interpretation of information, both new and old. Despite this fact, it is not an area of absolutes, nor does it predispose any person or company with great amounts of information and knowledge to necessarily be the smartest or most knowledgeable in their given field. It simply allows them to interpret new information from a larger accumulated knowledge base. With this understanding, it is fair to conclude that the interpretation of most business information results in the reinforcement or

progression of a certain belief system, which is typically focused strictly on economic issues.

Perhaps the direction that some companies should take to gain competitive and ethical advantage is to move beyond the contemporary furniture design industry's present understanding of itself: why it is focused on gathering a certain type of information (economics-based data), and to examine its foundations of knowledge (Haldane iii). To begin this inquiry, I believe that a basic methodological objective must be set that is focused on ethical standards in societal, economic and ecological issues.

Today, most managers and employees are trained to follow and respect historically functional design methodologies that adapt well to their fast paced environments. Questioning protocol, or long-standing strategic decisions, is often considered to be time wasted in larger corporations, or to be a personal attack on the owner (or manager) in smaller companies. However, when new ideas and thinking are deemed to be legitimate, logistical concerns, perceived implementation costs, or low return-on-investment, regularly prevent execution. New knowledge and information is often considered to be irrelevant or ineffectual to most companies unless it fits within their current logistical and decision-making systems. This closed-door approach to gathering, interpreting, and incorporating new information (and the possibilities that it holds) is forcing the CEOs and CFOs of the world to maintain a shortsighted economic approach to problem solving that is rarely rooted in ethics. As Hawken notes in *The Ecology of Commerce*, "the way our economy is organized today, businesspeople are right: doing the right thing might indeed put them out of business" (9).

This ethically challenging paradox is most obvious in the materials and processes specification stage of the design process. It is the critical point at which the designers' knowledge base is used to exert influence on the client's (or employer's) demands. Knowledge and motivation become linked together to produce action. Once action takes place, the results become actors themselves, asserting new variables into areas that have

been considered beyond the boundary of an artifact or of the ethical concerns that a designer must face, such as the future toxicity of a material, or the planned disposal of an artifact. Having a large economically focused knowledge base, or improperly analyzing information, may not only contribute to the potential for making inappropriate socio-economic and environmental decisions, it may cause them.

Today, hidden within the contemporary furniture industry, resides a vast quantity of current, accurate and accessible information. A slow, but growing understanding of this information, and of the true socio-economic and environmental consequences of unethical actions is beginning to occur. Corporations that respect and compete within this new arena are becoming industry icons, and will likely outperform all businesses that continue to rely on old knowledge and business models. One of the most notable cases of this form of restructuring is 3M's recent efforts to reduce pollution. "3M…announced that by 1997 (after 10 years) it had saved more than $750 million through pollution-prevention projects" (McDonough, Braungart 53). This project, though optimistic initially, was attempting to reduce emissions by the end of the decade (1999) by 90%, and to attain a zero emission rating sometimes after. As Hawken notes in *The Ecology of Commerce*, "…the plan require(d) the incorporation of environmental issues on all levels of business planning and is used as a factor in employee performance reviews. The 3M program is a example of making money from preventing waste, which for most companies is the first step to becoming more socially and environmentally responsible" (61).

If a paradigm shift is to occur in this industry's knowledge base and belief system, it will likely begin through assessing new and old information from an alternative ethical context that seeks to balance social, ecological and economic concerns, not just the latter. Practically speaking, if this shift is to occur, it will undoubtedly take place over an extended period of time unless the corporation can access, interpret and incorporate a vast

body of information into a new strategic plan that maintains their economic prosperity. (See: Case Study #1, Appendixes, "*Ford*")

I do not propose that greater amounts of information and knowledge will necessarily produce ethical decisions. However, I do contend that an objective and scientifically based design methodology whose purpose is, in part, to analyze information for relevance and importance will encourage a more holistic understanding of the short, mid, and long-term consequences of any action. This stream of thinking is reflected in the first pages of Paul Hawken, Amory Lovins and Hunter L. Lovins' *Natural Capitalism*, "There is now sufficient evidence of change to suggest that if your corporation or institution is not paying attention to this revolution, it will lose competitive advantage. In this changed business climate, those who incur that loss will be seen as remiss if not irresponsible" (Preface xiii).

1.3 Furniture, eco-efficient and eco-effective designs

In order to encourage and expedite this industry's movement towards a more constructive design methodology that uses ethics and current, accurate and accessible information as the foundation for decision-making, it is critical that the definition of an artifact, or piece of furniture, include the entire product. This new definition, I believe, should include an artifact, or any part or component of that artifact, that can assert its influence on, or within the larger system in which it resides. This expanded definition should encourage designers to reconsider the appropriateness of certain decisions, such as the use of PVC in fabrics, which causes off-gassing of toxic fumes; or, the use of Antimony in PET, which has been linked to causing cancer. Further, the product should be analyzed for its "life-cycle system", where matters that relate to its production, handling, distribution, use, and eventual disposal, will become a part of the life-cycle assessment, not just its use. The goal in clarifying these two terms is not to complicate the design process for some theoretical or academic reason; rather, it is to expand the designers' "vision from

the primary purpose of the product (its use) or system and consider the whole" (McDonough, Braungart 81-82).

Statistically, "Cradle-to-grave designs[2] dominate modern manufacturing. According to some accounts more than 90 percent of materials extracted to make durable goods in the United States become waste almost immediately" (McDonough, Braungart 27). At minimum, this statistic should raise concerns about manufacturing efficiencies, if not health, safety and ecological issues for all companies and consumers.

In light of this, designers should feel compelled to reinvestigate and study the complex relationship between materials, processes and their ability to become negative actors during the product's "life-cycle system". They should reconsider the artifacts' intended context of use, and the true appropriateness of specifying traditional materials and manufacture methods. With this heightened awareness, of the *seemingly* chaotic relationship between variables that produce and *affect* the entire product and its "life-cycle system", designers in the furniture design industry will be encouraged to move away from the use of eco-efficient[3] materials and processes, towards a system with greater potential - the use of eco-effective[4] materials and processes.

To understand the difference between these two design methodologies, McDonough and Braungart claim that eco-efficient designs seek to *reduce* the amount of material and energy input per product, and to *lessen* the amount of toxic waste that is put into the air, soil, and water (62). This design system, which very few companies use on any significant level today, attempts to do more with less. With this in mind, and within the

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[2] "They are the ultimate products of an industrial system that is designed on a linear, one-way *Cradle-to-grave* model." (McDonough, Braungart 27) This system does not consider the life-cycle of an artifact beyond its intended context of use – It designs for consumption and disposal.

[3] This design methodology "seeks to *reduce* the amount of material and energy input per product, and to *lessen* the amount of toxic waste that is put into the air, soil, and water" (McDonough, Braungart 62).

[4] This design methodology, and the term "Cradle-to-cradle", coined by Walter Stahl, operates on the "*continuous* repair, reuse, and remanufacturing" (Hawkins, et al.17) of *all* materials and components. There is virtually no unusable waste (material and energy) in this system of any kind.

context of this paper, I consider eco-efficient designs to be artifacts that achieve a Factor 4 (75 percent) to Factor 9 (90 percent) reduction in energy and natural capital consumption. These numbers reflect the goals that were discussed at the 1992 Earth Summit in Rio de Janeiro (United Nations).

In Case study #2 ("*InterFace - Pumps*"), Singaporean engineer Eng Lock Lee conveyed through his actions that even the most statistically proven data needs constant reassessment for accuracy, validity and timeliness. It is also of great relevance to note that he was educated at the same schools as many of his contemporaries and continues to use many of the same materials, processes and "engineering principles" as they (Hawken et al. 123). However, Lee's "designs are typically three to ten times more efficient than others, deliver better services, and cost less to build. The primary reason for his successes in these areas is all in how he *thinks*" (Hawken et al. 123). He approaches problems from a different perspective than most engineers and designers. Efficiency is the result of a non-linear, holistic approach to understanding and solving and problems. Multiple perspectives are considered and incorporated into a sophisticated design process that attempts to eliminate waste of every kind.

In contrast to this example of eco-efficient design, eco-effective designs incorporate a "closed-loop" system of manufacturing. This methodology, and the term "cradle-to-cradle", coined by Walter Stahl, operates on the "*continuous* repair, reuse, and remanufacturing" (Hawken, et al.17) of *all* materials and components. There is virtually no unusable waste in this system of any kind. Reflecting this approach, and that "many schools of thought hold that for a *sustainable society*, we need to move towards a point where we are reliant on 10% of the resources that are consumed by industrialized countries today *(per capita)*" (Manzini), I consider eco-effective designs to be artifacts that achieve a Factor 10 (90 percent) or greater reduction in energy and natural capital consumption.

Although the eco-effective model may seem impossible, or at least unprofitable to most businesses, *Interface*, one of the largest carpet manufacturers in the world, has been able to integrate all of the lessons and practices from eco-efficiency, and step well beyond its *reduce* waste principles, to integrate almost all of the *eliminate* waste requirements of eco-effectiveness, into all levels of their business - at a profit (See: Case Study #3, Appendixes, "*Interface - Disposal*").

As outlined in this Case Study #3, the Factor 31 savings that *Interface* attained, which amounts to a 97% reduction in the net flow of materials and energy, was the result of a considerable amount of information gathering from all departments within their company, consolidation and interpretation of it, and implementation of innovative action plans. Their knowledge base and understanding of its origins and purpose evolved as they rebuilt their company. Even a cursory observation of the large gains in efficiencies, and the virtual elimination of all waste categories, suggest that the improvements were not the result of a single process or material change, but the consequence of a holistic analysis and reconstruction of the entire design process. Old assumptions were questioned, and often discarded due to a lack of timeliness, legitimacy, or supporting data. *Interface* reconsidered what service they were attempting to provide, and if they were doing it in the most efficient way. Eventually, those at *Interface* realized that their understanding of their own business, market, and how to service it, was dated. As a reflection of this new approach to thinking within the business world, Hawken comments that, "The next business frontier is rethinking everything we consume: what it does, where it comes from, where it goes, and how we can keep on getting its service from a net flow of very nearly nothing at all – but ideas" (Hawken, et al. 81).

Perhaps the next step for progressive companies like *Interface* is to begin researching new technologies and ways of thinking that will allow them to produce artifacts that use biomimicry as a model – that is, to attempt to replicate the "waste equals food" patterns seen in Nature. If designers begin to work more closely with other industry professionals,

such as chemists, physicists, biologists and entomologists, this industry has the potential to achieve the same level of design efficiency, elegance and ecological balance as the spider's web – a nearly weightless thread that is, by ratio, stronger than Kevlar, is 100% organic, biodegradable and edible. In truth, the web is an artifact produced without toxins, and created by a self-sufficient factory that contributes to the worlds' ecology. Like the spider's web, what we create as designers and businesses, whether intentionally or not, is a part of Nature. Once discarded, and often while in use, these artifacts begin to affect other objects and elements during their decay. This new context, which is rarely considered in the design process, becomes another variable in the complex regenerative system that has been evolving in Nature for millions of years. It is an area where great amounts of profit can be made – economically, socially and ecologically.

1.4 Furniture and sociology

If we look at the pieces of furniture that we have purchased over the years, or consider the items that we may acquire in the future, from a personal, or even a broader sociological perspective, we should ask ourselves - what benefits do cheaper products really bring to us if they are polluting the soil and water, increasing the toxicity levels in our homes through off-gassing, or breaking after a short period of use? Bruce Nussbaum believes that industrial designers should reconsider their options in the context of "technological innovation". This methodology, he contends, is typically used to solve problems through the use of "new materials, new functionality, new production processes" - it considers few things other than the product itself. In his view, approaching "social innovation" as an alternative to technology-based solutions would allow the designer to understand and address a greater number of issues (Roberts 58).

Not unlike Nussbaum's theory, I feel that design innovation, in many consumers' and businesses minds, has become inextricably linked with technical *and* social innovation. This false perspective, which is largely directed by the marketing tactics of large

companies, tends to encourage a superficial analysis of an artifacts' contribution to society through contemplating Human-Factors (strictly based upon an artifact's usability and functionability) and certain Product-Trend issues such as Hedonism (Jordan 2). However, hidden beneath the 'skin' of the product, lies a library of disquieting social and ecological issues, such as the unknown material toxicity of a product, its biodegradability, or the work conditions under which the artifact was made. Within this context I agree with Nussbaum, but *do* believe that technical innovation is a justifiable solution to many of the problems that have been created by its unrestrained existence, and by the creation of unethically designed technical and non-technical artifacts.

In contrast to this appreciation for technology, I consider it to be nothing more than a complementary tool to ethical and critical thought. Building onto Alain Findeli's notion that, "(This) epistemological/methodological shift…has another important consequence on design responsibility. In effect, the systemic view implies that the making of an artifact, which usually is considered as the normal outcome of a design project, is no longer taken for granted. Within these complex systems, designers are expected to **act** rather than to **make**" (14). This ideology, though seemingly philosophical and academic in its logic, *is* practical if the outcome of the project is an artifact that improves the well-being of people, and does not adversely harm the ecosystem. At minimum, the successful design of an artifact should be judged against all comparable products on the market – there must be an improvement in the areas that relate to the product's pleasurable use, to the entire product and to its "life-cycle system". If not, I contend that it is simply adding to the pollution of meaningless objects.

Despite any good intentions that businesses may have, the unfortunate reality is that most industries continue to compete on a delicate mixture of price, aesthetics and performance. This intolerant market system, by its very nature, is designed to reward a select number of companies that can endure long-term market volatility. It is a system built around short-term gains, economically, ecologically and from a socio-cultural perspective.

However, companies such as *Ford, Interface,* and *Herman Miller* are exploring and fostering a potentially new kind of economic system that may reduce their exposure to market volatility by competing, at least in part, outside of the dominant model. They are finding innovative ways to reduce costs, improve profits and market share, and enhance their corporate image through reconsidering long-term social and ecological factors. Perhaps it is hard for some people to envision a time when their company will have to become socially competitive, but as more companies begin to encounter dramatic savings in these new areas, the current economic-based model is sure to become dated.

As a further testament to the legitimacy and relative simplicity that methodology is based upon, McDonough and Braungart claim that,

> If businesses are not using the "triple bottom line"[5] analysis as a strategic design tool, they are missing a rich opportunity. The real magic results when industry begins with all these questions, addressing them up front as "triple top line" questions rather than turning to them after the fact. Used as a design tool, the fractal allows the designer to create value in all three sectors. In fact, often a project that begins with pronounced concerns of Ecology or Equity[6] (How do I create habitat? How can I create jobs?) can turn out to be tremendously productive financially in ways that would never have been imagined if you'd started from a purely economic perspective. (McDonough, Braungart 154)

1.5 Furniture and economics

As outlined in the case studies and previous sections of this paper, certain businesses around the world are beginning to gain competitive advantage in unlikely areas and for vastly different reasons. One additional example of this is the strict new regulatory laws being instituted in Switzerland to significantly reduce the fabric industry's waste. This ruling was instituted to protect the people and the environment, but also rejuvenated and redefined the ways in which a larger international manufacturing plant could make profits (See: Case Study #4, Appendixes, "*Rohnert Fabrics*"). As Patrick Jordan notes, "Indeed, the issue of good design as a whole is moving *nearer*

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[5] The "triple top line" and "triple bottom line" considers and seeks to balance economic, ecological and equity issues in a manner that does not sacrifice one area over another.

[6] This is the equivalent of social issues as outlined in this paper.

to the top of manufacturers' agendas. This is largely due to the 'technology ceiling' that has been reached in many sectors of manufacturing industry. With technology being so advanced now, it is difficult for one manufacturer to gain a significant advantage over another in terms of, for example, production or technical reliability" (10). The challenge, then, is to elevate the quality and level of creative and ethical thinking, and jump beyond the linear gains that traditional production efficiency has been limited to.

Although I will not be able to address the issue of international manufacturing and trade in any great detail in this paper, it is critical to note the paradigm shift that is occurring in many sectors of the furniture industry. When considering and attempting to avoid the perceived high local and national costs of raw material, processing, waste management and labor, a growing movement towards off-shore production has further complicated the effort to balance ecological, social and economics issues. This stressful relationship can be summarized as follows:

1.6.1 *Economic issues*. Materials *are* slightly less expensive off-shore - This has encouraged companies to move production elsewhere. But, the *true* cost savings is due to two factors:
First, the growing buying power of bulk materials by off-shore manufacturers (Note - this buying power, and reduced material cost could be gained by domestic manufacturers if they were able to secure most of the domestic production of goods and services).
And second, international manufacturers in the developing countries do not have to incorporate the same degree of environmental costs as the developed nations (many of the domestic environmental laws are not enforced or do not exist off-shore). This reduces off-shore wholesale costs.

1.6.2 *Social issues*. Many domestic manufacturers are moving production off-shore to reduce labor costs. The primary social concern that relates to this business decision is the strategic and ethical implications that relate to work conditions abroad. I contend that it is unethical to expose another person to work or environmental conditions that would be deemed unacceptable on our own local or national soil.

1.6.3 *Ecological issues*. Many industrialists defend the decision to move manufacturing off-shore. They emphasize the positive economic investment in a foreign country, and that they are providing native people with jobs that would otherwise not be present. I question the legitimacy of this approach from an ethical, social and ecological point-of-view unless there is a long-term commitment by a company to provide meaningful employment that will truly improve the well-being of the community and country where it resides; *and*, to not affect any future generations negatively (i.e. through environmental waste/toxins).
From an economic point-of-view, national manufacturing should be able to challenge and approach the economic cost savings of off-shore production, through creative thinking (in part due to an increased knowledge), and a simplification of logistics that is encountered when manufacturing in a foreign country. However, when multi-national companies are not affected by location of manufacturing (typically due to the size of their global market), improvements in the ethical impact that they have in non-western spheres can be dramatically reduced through the application of the principles discussed in this paper.

1.6 Furniture and ecology: problems and opportunities

To support the thesis that it is possible to increase corporate profitability with a "radical reduction throughput" (Hawken, et al. 61), the following statistics and commentary should be considered in the context of ecological problems *and* opportunities:

PROBLEM – In the book *Cradle to Cradle,* McDonough and Braungart state that there are "approximately eighty thousand defined chemical substances and technical mixes that are produced and used by industry today (each of which has five or more by-products), only about three thousand so far have been studied for their effects on living systems" (41-42).

OPPORTUNITY – Industry should use ecologically benign substances that aid people's development (not limit it). This strategy would produce a more healthy and productive workforce, increase the productivity of our natural resources, and become a successful marketing tool for any company.

PROBLEM – Tracking and eliminating the use of toxic parts and components is an important step in reviving the eco-system. However, carcinogens like benzene, which is banned as a solvent in the United States, can be shipped there from other countries, unknowingly, as a component of rubber parts.

OPPORTUNITY – Every artifact should have a "material make-up tag" attached to it, or be accessible though a coding and tracking system. This policy would dramatically reduce the pollution of landfill sites, allow for the separation and reconstitution of materials, and encourage the ethical use of materials and their composites.

PROBLEM – Consumption and waste patterns in the developed nations of the world are reaching dangerous levels. "Americans waste or cause to be wasted nearly 1 million pounds of materials per person per year" (Hawken, et al. 52).

OPPORTUNITY – Forcing industry to pay for the use of, and regeneration of natural resources that they consume, will encourage creative thinking and problem solving. Abuse and misuse will decrease.

PROBLEM – Some companies and consumers prefer to use materials and products that are recycled or have recycled content. Unfortunately, recycled product or products that have recycled content do not automatically make them ecologically benign, or socially responsible - especially if they were not designed for recycling (Hawken, et al. 52).

OPPORTUNITY – This ecological (and health) concern opens the door for new companies to innovate 'healthy' products such as Envirez 5000 (a soy and corn resin), or the Climatex fabric range from *Carnegie* (which is 100% biodegradable/compostable).

PROBLEM – Energy consumption and waste is harming the environment and the economic stability of many companies. In the book *Natural Capitalism*, it is stated that "The United States still gets three-fifths of its aluminum from virgin ore, at twenty times the energy intensity of recycled aluminum" (Hawken, et al. 50).

OPPORTUNITY – The present 'design system' for collecting used aluminum is extremely inefficient. If government forced consumers to recycle

aluminum (and other products), and industry was involved with storage and handling, dramatic decreases in costs and strain on the environment would be achieved.

Nigel Whiteley writes that, “designers can no longer take refuge from responsibility for their own actions and continually repackage the same old consumer goods at a time when issues about consuming and its relationship to the world’s resources and energy need urgently to be acted upon” (3). Whiteley is acknowledging a dysfunctional socio-economic and ideological system that needs change and leadership. This leadership, I feel, should come from the groups that have been perpetuating the problems that are associated with consumption and the unwise use of energy and materials: the designers and businesses that they work for. Although this new leadership role may sound unprofitable and punitive, statistics and case studies support the feasibility of this approach. The efforts being put forth by companies such as *Herman Miller, Formica Ligna, Ford Motors, Carnegie, Rohnert* and *Interface* reflect a true understanding of where industries could go. They are not following a superficial trend or employing a new marketing strategy to become “sustainable”, “environmentally friendly”, or “green”. These massive companies are rebuilding and redefining themselves to become highly profitable and admirable industry icons. Ethical solutions and creative thinking are producing profits, not short cuts.

1.7 Furniture, style and aesthetics

It may seem somewhat outlandish to discuss style or aesthetics so late in this paper; however, this layout is an accurate reflection of where this topic should reside in the leading contemporary furniture design industries design methodology. This community of designers and consumers has become so accustomed to seeing interesting form over the last fifty years that style alone rarely gains any great degree of attention or legitimacy on the market or at the beginning of the design process. Although the subtle use of organic and geometric forms (I call ‘georganics’) is becoming desirable to the international furniture design market, there is a renewed

quest for artifacts with substance. Not the aesthetic or material substance that was encountered in the past decades, but something more meaningful, some additional layer that people can attach to their desire to buy.

The contemporary furniture design industry, then, must attempt to understand this new demand, and if needed, reorient it in an ethical direction. Considering this, the design objective as I see it, is to create furniture that incorporates unique and innovative materials that are used in different ways, and are occasionally, foreign to this industry - materials that encourage conversation and intrigue, both in their aesthetic, and in their material make-up. The form that an object takes on is equally important, but must correctly represent and complement the materials' hidden story. The overall quality of the piece must promote questions, critical thought and discussion. Whether directly or indirectly, form, material, color and texture hold the ability to create and change emotion. Like fine art, contemporary furniture represents a person's sense of style, their values, ideals, and even a degree of their intellectual ideology. With this understanding, I believe that the material make-up of a piece of furniture could begin to represent the consumer's concern and growing interest in social, economic and ecological equality. Owning a couch that was produced in an ethical manner, which is made of durable, biodegradable and non-toxic materials that do not off-gas, may become a significant part of the artifact's image in the near future. This new broader definition of style is likely to become the latest demand of this discerning consumer, and the arena that designers and manufacturers will have to compete in.

The task, then, is to train designers to adapt to these new challenges. Only after harvesting information, interpreting it, and translating it to usable and constructive knowledge can a successful and ethically designed artifact meet all of the requirements of this broadened approach that could be called *New Materialism*.

1.8 Summary

In many ways, design is just applied foresight. It attempts to define problems and provide solutions through action. In reality though, it is a phenomenally complex field that, like this reductive definition, attempts to distill problems into logical, elegant solutions. Designers who act ethically and truly attempt to understand the scope and intricacies of any given project are often required to investigate fields that extend beyond their immediate area of expertise and training, such as sociological, ecological and economic issues. These requirements are symptomatic of the complexity of this field and of the world that we live in. To deal with this density of issues, companies institute design methodologies to avoid a state of chaos. Often, they are company and field specific, but are typically built around the dominant economic-based model.

The most appropriate way to summarize my findings, and hypothesis, is to present them in the form of a condensed design methodology. Central to this methodology is that any improvements in social or ecological conditions must not sacrifice the economic prosperity of a project or of the company and that the significant incorporation of ethics in the design process will force the investigation and research of alternative design solutions for the entire product and its “life-cycle system”.

This revised design methodology attempts to balance *social, economic and ecological concerns* through a very high level of research (of current and accurate information). The analysis and interpretation of information, and formulation of conclusions will come from analytical and empirical data that uses a holistic and ethical approach to the design objective. In turn, these conclusions will allow companies to design an artifact that uses eco-effective or, if feasible, eco-efficient design practices.

During the artifacts *production* it will use:

a) **Materials:**
- that have low toxicity levels and do not bio-accumulate. Assume that "everything spreads and nothing disappears". (Nattrass, et al. 65) – *eco-efficient.*
- or, using materials that are in a closed-loop cycle such as "biological[7] or technical nutrients[8]" (McDonough, Braungart) - *eco-effective.*

b) **Material Intensity:**
- must be reduced in every part and component that make up an artifact (including packaging) – *eco-efficient.*
- or, dramatically reduce the amount and *kind* of materials used in every part and component that makes up an artifact (must use eco-effective materials) - *eco-effective.*

c) **Energy:**
- intensity must be reduced during the fabrication of parts and components – *eco-efficient.*
- or, use 'low-impact' energy sources such as wind or solar power must complement a reduction in energy expended during the fabrication of all parts and components (and during transportation) - *eco-effective.*

d) **Waste:**
- of all kinds must be reduced during the fabrication of parts and components –*eco-efficient.*
- or, all kinds of waste must be reduced during the fabrication of parts and components, *and* all kinds of unusable waste (that are not biological or technical nutrients) should be eliminated - *eco-effective.*

e) **Complexity:**
- of manufacturing steps and the number of parts and components must be reduced – *eco-efficient.*
- or, there must be a dramatic reduction of steps, parts, components and processes that do not contribute to balancing ecological and social issues (must use eco-effective items) – *eco-effective.*

f) **Process:**
- toxicity must be reduced – *eco-efficient.*
- or, eliminate all toxic processes during the artifact's "life-cycle system" - *eco-effective.*

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[7] "A *biological nutrient* is a material or product that is designed to return to the biological cycle- it is literally consumed by microorganisms in the soil and by other animals." (McDonough, Braungart 105)
[8] "A *technical nutrient* is a material or product that is designed to go back into the technical cycle, into the industrial metabolism from which it came…in a closed-loop cycle." (McDonough, Braungart 109)

g) **Monitoring:**

- production more closely in an effort to decrease inefficiencies and wasteful rejects – *eco-efficient.*
- or, monitor production processes with sophisticated human and computer systems to dramatically reduce rejects and waste of all kinds – *eco-effective.*

h) **Design**:

- for improvements (and for increasing or decreasing production levels) over the life of the product – *eco-efficient.*
-or, design the artifact under the assumption that there will be continuous flow of improvements in materials and processes throughout the product's "life-cycle system" – *eco-effective.*

During the artifacts *use*:

a) No material toxicity, off-gassing or detrimental health consequences should occur.
b) A high level of "product-pleasure" should occur through its use and/or ownership, and appeal to consumer's new image demands.
c) A high level of quality should exist to extend its useful life (or could be repaired if broken).

During the artifacts *disposal* stage:

a) Easy component disassembly must be possible for sorting constituent parts and materials.
b) Be manufactured from one material that is a "biological or technical nutrient".

2. Research and analysis:

2.1 Introduction

At this point in time there is no one material or process that can solve all furniture design requirements all the time. This may seem like an unnecessarily obvious comment, but it raises an interesting question for those designers and companies who maintain an open mind and are interested in philosophical and critical thinking. Nanotechnology, for example, is a relatively new area of science that is exploring the possibilities of organizing molecules in strategic ways to produce artifacts out of the manipulation of tremendously small particles. Although the implementation of this technology is certain to raise ethical questions, the authors of *Natural Capitalism* anticipate a time when industry will be able to produce consumer objects with virtually no waste and little energy expansion in the process. They note that, "The technology is a feasible one, not violating any physical laws" (Hawken, et. al 73).

Although the development and practical application of this futuristic technology is still very uncertain, at minimum, it displays the necessity for designers and companies to seek a constant flow of current and accurate information, and to be open to new possibilities and ways of thinking about their business, the artifacts that they sell, and how they impact the world around them. This, I would contend, is one of the greatest competitive advantages that a company could gain in the long-term: to constantly reassess the information that they accumulate, and to intermittently analyze their ethical and methodological approach to staying profitable.

2.2 Materials and Processes

Inspired by this stream of thinking, my initial approach to accumulating and editing information on materials and processes was exceptionally broad. In the initial research stages, the only criteria that I limited myself to were the following:

A ***material*** must include at least one of these items:

a) it must be aesthetically appealing to a segment of customers in this industry
b) it must be made of a "biological or technical nutrient"
c) it must be modest in price compared to similar products
d) it must be accessible on a local or regional scale
e) it must be easy to manufacture
f) it must be extremely durable
g) it must be built in an ethical manner (related to work conditions)
h) it must reduce the complexity or number of materials required
i) it must allow the entire product to have an eco-effective or eco-efficient "life-cycle system"

A ***process*** must include at least one of these items:

a) it must reduce or eliminate energy waste
b) it must reduce or eliminate material waste
c) it must reduce or eliminate toxicity
d) it must reduce the complexity of processes/logistics
e) it must be accessible on a local or regional scale
f) it must allow for multiple production volumes
g) it must be inexpensive in comparison to comparable processes
h) it must be located in a factory where there are ethical work conditions
i) it must be eco-efficient or eco-effective

My research and findings uncovered dozens of non-toxic and biodegradable materials that are produced, and in many cases grown, in very ethical manners (both ecologically and sociologically). Many of these materials have aesthetic qualities that are matched by few competitors in any market. In some cases, wholesale pricing is more competitive than comparable products on the market, especially when material durability is considered. Although innovations in processes were limited in

comparison to those of materials, a number of impressive results were found, such as those at *Rohner* in Switzerland.

At the end of my research stage, I had compiled, edited and organized approximately 1,000 pages of information on current materials and processes that are applicable to the contemporary furniture design industry. This information complemented, and at times made me question, my assumptions about the possibilities that materials and processes have on the design of an artifact. But, perhaps most significantly, this large information base enabled me to produce more designs that were both aesthetically appealing and ethically responsible.

2.3 Summary

In order to test the functionality and flexibility of my ideas, hypothesis, and proposed design methodology (on pages 19–21), four different design briefs were developed as an assessment tool to analyze the legitimacy of any proposed design solution (the lay-out of the first page of this brief was influenced by similar ones from *Target International* and *Palliser Furniture*). On the first page of the design brief, at least one primary objective, and typically two or more secondary objectives are listed. For example, one of the design briefs that was created focuses on producing a mid to upper-end upholstered chair (or lounge) for the "aesthetically and fashion conscious market looking for innovative designs". The secondary objective in this design brief notes that the target market is interested in "high-durability and the use of non-toxic materials" (see Design Brief #1). Although more details and objectives are listed throughout all of the design briefs, even this small amount of information would enable a designer and customer to constantly evaluate the appropriateness of proposed materials, processes, aesthetics, and cost throughout the design and production stages of the design process.

To encourage a greater degree of quantifiable comparisons between the design brief and the proposed solution (by ANT ID), a design proposal was created using a similar format. In this case, the customer(s) would be asked by ANT ID to fill out both pages of their in-house design brief. On the second page of the design brief (and proposal), are the graphic sections that target and attempt to measure the various methodological goals. Although it is challenging to accurately measure social and ecological impact (especially given the length of this paper), supporting data would normally be attached to each proposal as it relates to these areas (including economic related information).

Upon reaching the proposal stages of my thesis work, when I was ready to begin constructing the finished pieces of furniture - the prototype versions - financial limitations forced me to use substitute materials and processes for some of the production versions. However, in both cases, I have used a design proposal to display the differences between the two proposed versions. In all cases, the prototype's versions did not meet the objectives laid out in the briefs. Although this is not overly surprising, it is significant in the sense that it displays a visual and quantifiable degree of separation between the goals (or the brief) and the two proposals. This seemingly simple and inconsequential comparison that includes but extends beyond economics will encourage the creation of more ethically produced artifacts through a higher level of creative thinking and investigation. After all, who wants to specify, *in writing*, the creation or fabrication of socially or ecologically harmful products?

3. Conclusion

Designers have a significant ethical responsibility when creating any artifact. There are few people in any industry where one person has so much influence on what an artifact is made of, how it is made, or where it is made. To date, this role and the level of accountability that goes with making such decisions, has been limited and taken too lightly by many members of this community. Fortunately, there is a small group of designers that are raising corporate expectation levels, and pushing the design industry's understanding of its current limitations and of the possibilities that ethical approaches to problems solving can have.

This small cluster of designers are displaying an exciting new level of flexibility and are influencing large, historically inflexible, multi-national companies in ways that were unimaginable ten to twenty years ago. Seemingly obtuse, unprofitable and impractical ideas are being presented, and ultimately converted, into new corporate mission statements that are cutting costs and improving profits at unimaginable scales. The common link between all of these design companies, and the solutions that they propose, appears to reside in a knowledge base that provides ethical solutions to the entire product and its "life-cycle system". One of the consequences of this new approach to designing artifacts that I am most interested in, is how a broadened understanding of problems can promote, with the correct design methodology, a greater number of material and process options for the designer to select from. Perhaps the most exciting aspect of this new approach from a corporate perspective is that it continues to address the economic realities of business, but not to the exclusion of its ecological and social responsibilities.

The key, then, is to equip designers with an expanded 'tool box' of knowledge. Designers need access to options, information, and alternatives when approaching a design problem. They need current, accurate and accessible information.

Additionally, they need a sound design methodology that complements innovative thinking and problem solving. It is no longer appropriate or desirable to design strictly from an intuitive perspective as it was in the past. There is too much for companies to lose in today's competitive international business environment. The contemporary furniture designer must recognize and adjust their approach to problem solving - they are in the magical position of linking economic, social and ecological issues together in a way that can provide an increased level of profits and balance for these three cornerstones of any developed democratic society.

Despite highlighting *Rohnert, Interface* and *Ford* in the case studies of this paper, I recognize that a significant portion of their desire for change could be traced back to a need for maintaining competitive advantage and for reducing costs. In light of this, it could be argued that many of the ethically based decisions were not really planned or intentional, but fortunate consequence of the "triple bottom line". Further, such arguments may suggest that these companies are still dependent on the old, purely economic-based model that grew out of the Industrial Revolution. Even if these arguments were true, I would still defend and applaud the actions of these companies as being so significant from an exploratory and educational perspective, that they have proven the legitimacy and profitability of moving towards a higher platform of eco-effective design - even if all of the strategic decisions were not made for entirely altruistic reasons.

Naturalists suggest that "nature does not compromise; nature optimizes" (Hawken, et al. 112). In reality, this is exactly what every business is attempting to achieve - optimization. The very essence and longevity of a business is dependent upon maintaining profitability, and in some cases growth, not unlike in nature. I would argue that no one of the three areas that I have highlighted, social, economic, and ecological, may be privileged without negative consequences, at some point in time. Asymmetry is not rewarded in the long-term, in either business or in nature.

This line of thinking greatly influenced the design methodology that I attempted to develop and follow when designing my furniture pieces. In terms of the aesthetic qualities that my furniture has taken, my aim was to design and produce a diverse line of furniture that questioned previous conventions. Aesthetic topics or considerations such as the hidden structure and negative space of an artifact became spring-boards for offering something new to the market. The sculptural qualities of negative and positive space along with the hidden or suggested internal spaces and the material definitions of the artifact, and its function were questioned in a visual manner. For example, is the outermost part of a lamp always considered to be the shade, or is it the first object covering the bulb? Is it undesirable to show off the frame or internal space of an upholstered living room chair? In the end, I found it necessary to complement the aesthetic ingredients of my products, which is in part derived from a philosophical perspective about life, with a sound design methodology.

From a philosophical and methodological point-of-view, I am interested in designing and producing long lasting, durable artifacts. This approach complements my interest in designing items that are timeless and not overly trend dependent, therefore, not becoming victim to dated styles and being thrown out after a short-term trend has passed- durability is important with long-lasting, timeless designs. Further, I am interested and heavily influenced by the simple geometric and organic forms seen in nature, that I call 'geo-organics', and the biophilic notions of love of the outdoors. These connections with nature, business and art are intended to provide the viewer and end-user with a sense of comfort, familiarity and confidence in the piece of furniture.

4. Design and fabrication of products

4.1 Design Brief #1 and Design Proposals

Design Brief

Date: November 1, 2002

Customer: XYZ Furniture Inc.

Design Brief #: 001

Category - Upholstered livingroom side chair.

Primary objective(s):
Target customer - European, Japanese, USA and Canadian customers that are "aesthetically and fashion" conscious, looking for innovative new designs, and who are familiar with high-end contemporary furniture design companies.
Target retailer - Limn (San Francisco), Design Within Reach (USA mail order), Fruh (Germany)
Target retail - US$1500 (mid to upper end)
Other - Decrease labor costs during fabrication (without increasing other fabrication costs)
- Strict use of eco-efficient and eco-effective materials and processes
- Design parts and components so they can be replaced with more efficient ones in the future if volumes increase.

Secondary objective(s): Simplify number of parts and components (also easy disassembly)

Customer demographics - 35-50years, mostly female (purchasers), urban, $150,000+ income/household
Secondary customer - New urban professionals looking to purchase a "highlight piece" for the living room, law offices, lounges and "exclusive" commercial settings

Recommended materials: Xorel, William McDonough IV Collection, Contemp Series
Material supplier (respectively): Carnegie, DesignTex, Rohnert

Recommended production processes: Vacuum forming, injection molding, open
Manufacturer: North America or Europe

Required finishes: Low maintenance metal frame - Stainless steel, brushed aluminum (anodized)

Possible = features: Open
Possible new technologies: High production vacuum forming, injection molding, liquid "foam-in-place"

Key competition:
Low-end: Bombast (Canada), Mike (USA), Natuzzi (Italy)
High-end: Ligne Roset (France), B & B Italia (Italy), Moroso (Italy)

Volume dossibilities (annual): 2,000 units/year

Desired due date - Production drawings: December 15, 2002
Desired due date - Prototypes: February 4, 2003
Scheduled production date: April 1, 2003

Unusual benefits of proposed product:
- Draw in environmentally sensitive customers through careful selection of fabrics and other components.
- Reduced production cost through decreased labor and simplification of parts - improved margin
- Unique design to promote innovative qualities of company
- Low investment in material and process research
- Increased worker productivity due to healthy work conditions

Possible draw-backs of proposed product:
- High cost and aesthetic may decrease potential size of market.

Design Brief

Material, process and artifact analysis:

Production stages:

		Standard 0 1 2 3 / Eco-efficient 4 5 6 7 8 9 / Eco-effective 10 +	Actual (/20)
a) Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	8
b) Work conditions:			
-During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	8
c) Material intensity:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	10
d) Energy intensity:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	8
e) Waste:			
-During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	8
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	8
g) Process toxicity:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	8
h) Monitoring levels:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	10
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	8

During artifact's use:

		Standard 0 1 2 3 / Eco-efficient 4 5 6 7 8 9 / Eco-effective 10 +	
a)Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	9
b)Quality and durability level of product:	Factor	X	8
c)Degree of "product-pleasure":	Factor	X	10

During artifact's disposition:

		Standard / Eco-efficient / Eco-effective	
a)Difficulty of component disassembly:	Factor	X	8
b)Impact ecosystem during decay:	Factor	X	9
		Total:	140 /21

EXPECTATION LEVEL:	**FACTOR :**	**7**

Date: December 1, 2002

Design Proposal

Customer: XYZ Furniture Inc.

For Design Brief #: 001
Proposal: #1 Prototype/Batch production version

Product Name: "Punch Press" upholstered chair (optional non-upholstered)

Solutions to primary objective(s):
- Proposed retail - US$1500
- Decrease labor costs during fabrication through a significant reduction in required parts and components
  - there are only four major components to chair - Frame, plastic seating shell, foam and fabric
  - 1/8" *Vivac* plastic vacuum formed plastic seat
    - is non-yellowing polypropylene (does not fatigue, break or crack easily)
    - has 15% material waste due to off-cuts from vacuum forming process
    - is potentially recyclable (as a technical nutrient)
  - there is a significant reduction in the number of frames needed in inventory (any seating component can fit on any frame)
  - foam handling (labor) is reduced through die cutting foam
  - frame finishing is limited (#4 stainless steel is pre-brushed) - Only welded joints must be finished
  - fabric is made by *Kvadrat* (very high Eco-effective policy), is 100% wool
  - viscoelastic foam is 50% vegetable matter

Solutions to secondary objective(s): High durability of entire piece, use of non-toxic fabrics
- frame is made from stainless steel (easy to repair minor scratches and is highly durable)
- there are 32 fasteners (screws) on the entire chair
- the plastic and upholstered seating component friction fits onto any frame without fasteners

Proposed materials: *Divina* fabric, viscoelastic foam, #4 stainless steel, extruded aluminum, ABS
Material supplier (respectively): *Kvadrat, Carpenter,* open, open, open.

Proposed production processes - Vacuum formed (plastic seat), die cut (visoelastic foam), Tig welded stainless steel, \ extruded aluminum

Manufacturers: Local, national or international

Proposed finishes: Low maintenance metal frame - Stainless steel, powder coating

Proposed features: None
Optional technologies/materials/processes - None

Proposed production date: April 1, 2003

Unusual benefits of proposed product:
- Draw in some environmentally sensitive customers through the careful selection certain fabrics and foams.
- Reduced production and handling costs - compared to conventional designs
- Unique design to promote innovative qualities of company through a reduction of parts and assembly requirements (also easy disassembly).
- Very low investment in molds and dies
- Fast production processes allow for a reduction of inventory.

Possible draw-backs of proposed product:
- Aesthetics limit size of potential market to mid to upper end
- Limited environmental sensitivity with plastic and foam waste

Material, process and artifact analysis:

Design Proposal

Production stages:		*Standard* · *Eco-efficient* · *Eco-effective* (0 1 2 3 4 5 6 7 8 9 10+)	*Actual (/10)*
a) Proposed materials: -Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor		3
b) Work conditions: -During manufacturing of material:	Factor		2
-During manufacturing of product:	Factor		6
c) Material intensity: -During manufacturing of material:	Factor		6
-During manufacturing of product:	Factor		8
d) Energy intensity: -During manufacturing of material:	Factor		2
-During manufacturing of product:	Factor		4
e) Waste: -During manufacturing of material:	Factor		4
-During manufacturing of product:	Factor		4
f) Complexity of manufacturing: -During manufacturing of material:	Factor		3
-During manufacturing of product:	Factor		8
g) Process toxicity: -During manufacturing of material:	Factor		3
-During manufacturing of product:	Factor		7
h) Monitoring levels: -During manufacturing of material:	Factor		2
-During manufacturing of product:	Factor		8
i) Design for improvements (and for varying production levels) over the life of the product:	Factor		10
During artifact's use:		*Standard* · *Eco-efficient* · *Eco-effective* (0 1 2 3 4 5 6 7 8 9 10 15 20)	
a)Proposed materials: -Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor		6
b)Quality and durability level of product:	Factor		8
c)Degree of "product-pleasure":	Factor		10
During artifact's disposition:		*Standard* · *Eco-efficient* · *Eco-effective*	
a)Difficulty of component disassembly:	Factor		9
b)Impact ecosystem during decay:	Factor		4
		Total:	**117** /21
EXECUTION LEVEL:		**FACTOR :**	**5.5**

Date: December 15, 2002

Design Proposal

Customer: XYZ Furniture Inc.

For Design Brief #: 001
Proposal: #2 (Production version)

Product name: "Punch Press" upholstered chair (optional non-upholstered)

Solutions to primary objective(s):
- Proposed retail - US$1500
- Decrease labor costs during fabrication through a significant reduction in required parts and components
  - there are only four major components to chair - Frame, plastic seating shell, foam and fabric
  - there are 16 fasteners (screws) on the entire chair
  - fabric is made by *Rohner in Switzerland (very high Eco-efficient policy), is 100% compostable*
  - there is a significant reduction in the number of frames needed in inventory (any plastic seating component can fit on any frame)
  - all milling of plastic components (in Proto-type version) are eliminated because of "zero" waste injection molding process
  - injection molded plastic seat:
    - is made from Envirez 5000, a soy and corn based resin.
    - has no material waste due to injection molding process
    - is recyclable (as a biological nutrient)
  - compression molded *Zotefoam r*educes labor and virtually eliminates foam waste.
  - frame finishing is limited (#4 stainless steel is pre-brushed) - Only welded joints must be finished

Solutions to secondary objective(s): High durability of entire piece, use of non-toxic fabrics
- frame is made from stainless steel (easy to repair minor scratches and is highly durable)
- foam handling (labor) is substantially reduced through "compression molding" cross-linked polyethylene *Zotefoam*
- the plastic and upholstered seating component friction fits onto any frame without fasteners

Proposed materials: William McDonough IV Collection fabric, Zotefoam, Envirez 5000, #4 stainless steel, extruded aluminur
Material supplier (respectively): DesignTex, Zotefoam (Europe), Ashland Inc., open, open.

Proposed production processes - Injection molding (plastic seat), compression molding (foam), extruded aluminum friction-fit fastening system, Tig welding
Manufacturers: North America or Europe

Proposed finishes: Low maintenance metal frame - Stainless steel, powder coating
Proposed features: Friction-fit fastening system - frame to seat
Optional technologies/materials/processes:
- Compression molding foam and fabric into one unit (is fabric dependant).
- *Envirez 5000* could be reinforced with hemp.

Proposed production date: April 1, 2003

Unusual benefits of proposed product:
- Draw in environmentally sensitive customers through the careful selection of eco-efficent and eco-effective materials and processes.
- Reduced production and handling costs - Note all materials specified are price competitive with typically specified materials and processes.
- Unique design to promote innovative qualities of company

Possible draw-backs of proposed product:
- Aesthetics limit size of potential market to mid to upper end
- Significant investment in compression mold and in injection mold

Material, process and artifact analysis:

Design Proposal

Production stages:

		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	Actual (/10)
a) Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	8
b) Work conditions:			
-During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	8
c) Material intensity:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	9
d) Energy intensity:			
-During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	8
e) Waste:			
-During manufacturing of material:	Factor	X	7
-During manufacturing of product:	Factor	X	9
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	9
g) Process toxicity:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	8
h) Monitoring levels:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	9
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	5

During artifact's use:

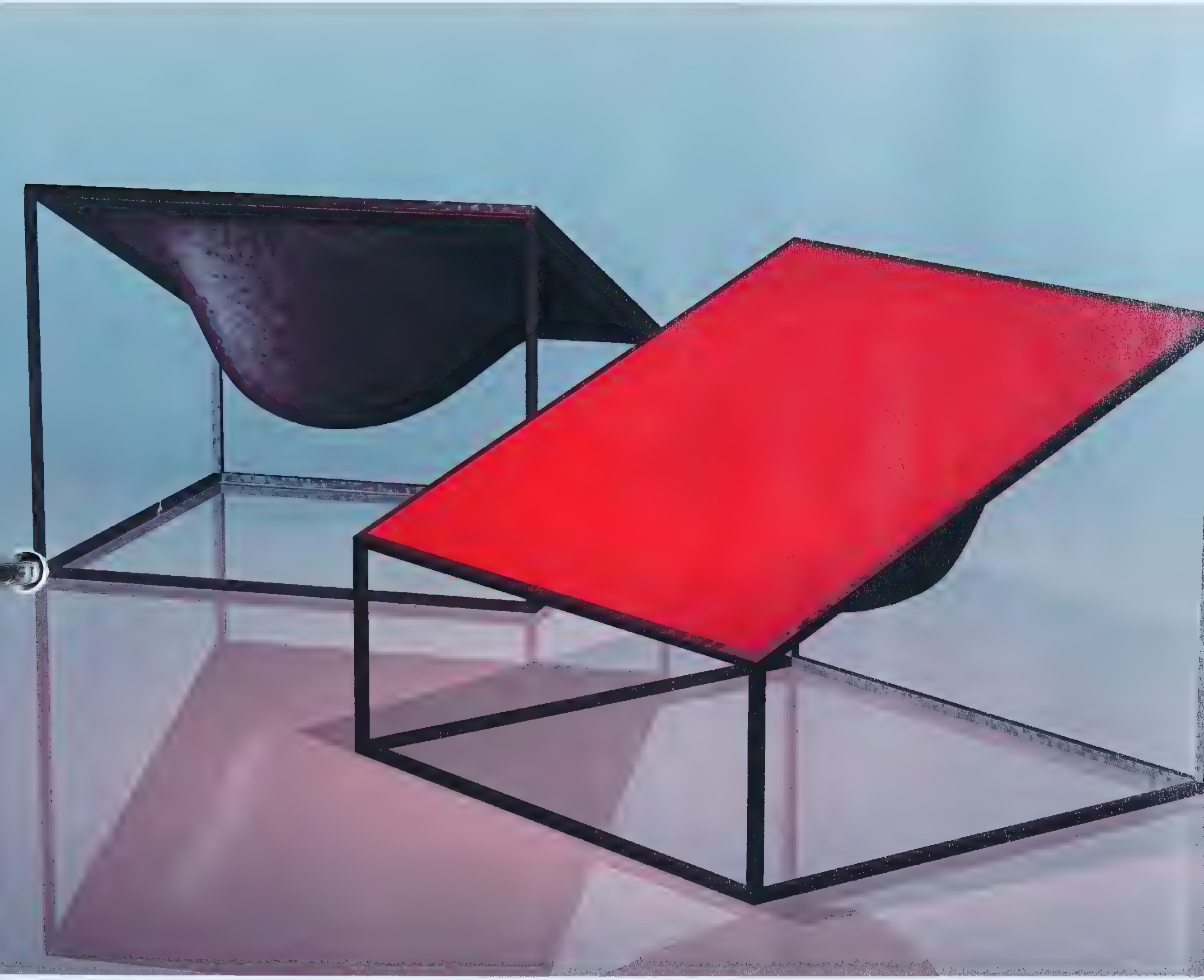
		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	
a)Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	10
b)Quality and durability level of product:	Factor	X	9
c)Degree of "product-pleasure":	Factor	X	10

During artifact's disposition:

		Standard / Eco-efficient / Eco-effective	
a)Difficulty of component disassembly:	Factor	X	9
b)Impact ecosystem during decay:	Factor	X	9
		Total:	**169** /21

EXECUTION LEVEL:	**FACTOR :**	**8**

Punch Press Chair



Depth	Width	Height
33"	36"	27"

4.2 Design Brief #2 and Design Proposals

Design Brief

Date: November 15, 2002

Customer: XYZ Furniture Inc.

Design Brief #: 002

Category - Side table lamp (option to extend into hanging, floor standing and track lighting versions)

Primary objective(s):
Target customer - USA and Canadian urban professionals (in the conservative/contemporary market) looking for a visually unique lamp for side tables or desks.
Target retailer - Design Within Reach (USA mail order), Filamento (SanFrancisco), Loft (NYC)
Target retail - US$200-250 (mid to upper end)
Other - Must use common manufacturing techniques for shade (glass blowing) and metal base and stem.
- Product is for low to mid-end market. Reduced production costs are critical.

Secondary objective(s): Ease of component assembly and disassembly
Decrease waste and energy consumption in production stages

Customer demographics - 35-50years, mostly female, urban, $75,000+ income/household, North America, Europe
Secondary Cestomer - University and College graduates looking to refurnish an element of their decor. Cafes, bars, workplace settings.

Recommended materials: Aluminum, steel, glass, plastic
Material supplier (respectively): Off-shore suppliers (China, etc.)

Recommended production processes: Blown glass, casting, injection molding, stamping, welding
Manufacturer: China (low cost off-shore)

Required finishes: Low maintenance, non-rusting, and low shade breakage

Possible features: Open
Possible new technologies: None

Key competition:
Low-end: Lite Source (USA)
High-end: George Kovacs (USA), Resolute (USA), Lucitalia (Italy)

Volume possibilities (annual): 10,000 units/sku/year

Desired due date - Production drawings: December 15, 2002
Desired due date - Prototypes: February 4, 2003
Scheduled production Date: April 1, 2003

Unusual benefits of proposed product:
- Reduced production cost - improved margin (Chinese production costs)
- Unique design to promote innovative qualities of company
- Easily produced due to accessible production processes
- Low investment in material and process research

Possible draw-backs of proposed product:
- Limited balance of Ecological objective in manufacturing depending on final materials and processes used.
- Limited attention to "post-consumption" or disposal.
- Limited balance of Sociological objective in manufacturing due to "controls" in China.
- Limited attention to natural resource consumption (or reduction)

Design Brief

Material, process and artifact analysis:

Production stages:

Scale: *Standard* 0 1 2 3 — *Eco-efficient* 4 5 6 7 8 9 — *Eco-effective* 10 +

		Actual (/20)
a) Proposed materials:		
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	0
b) Work conditions:		
-During manufacturing of material:	Factor	0
-During manufacturing of product:	Factor	0
c) Material intensity:		
-During manufacturing of material:	Factor	0
-During manufacturing of product:	Factor	2
d) Energy intensity:		
-During manufacturing of material:	Factor	0
-During manufacturing of product:	Factor	2
e) Waste:		
-During manufacturing of material:	Factor	0
-During manufacturing of product:	Factor	2
f) Complexity of manufacturing:		
-During manufacturing of material:	Factor	0
-During manufacturing of product:	Factor	4
g) Process toxicity:		
-During manufacturing of material:	Factor	0
-During manufacturing of product:	Factor	0
h) Monitoring levels:		
-During manufacturing of material:	Factor	0
-During manufacturing of product:	Factor	4
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	0

During artifact's use:

Scale: *Standard* 0 1 2 3 — *Eco-efficient* 4 5 6 7 8 9 — *Eco-effective* 10 +

a)Proposed materials:		
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	0
b)Quality and durability level of product:	Factor	2
c)Degree of "product-pleasure":	Factor	10

During artifact's disposition:

Scale: *Standard* — *Eco-efficient* — *Eco-effective*

a)Difficulty of component disassembly:	Factor	2
b)Impact ecosystem during decay:	Factor	0
	Total:	26 /21

EXPECTATION LEVEL:	FACTOR :	1

Design Proposal

Date: November 15, 2002

Customer: XYZ Furniture Inc.

For Design Brief: #002
Proposal #1 (Prototype/Batch production version)

Product Name: "Slice Lamp"

Solutions to Primary objectives:

-Proposed retail: US$300
-Vacuum formed plastic "outer" shade (two part are joined together). Unfortunately, this process is very labor intensive.
-Stem and base are made from stainless steel. Although the cost of steel and aluminum is less per pound, the use of stainless steel eliminates the need (and costs) of protective coatings to prevent rusting.

Solutions to Secondary objectives:

-There are only *two* materials in the lamp, acrylic and stainless steel (not including wiring or the socket), and *four* primary parts (the socket and wiring, the outer and inner shade, the stem and the base. This decreases the complexity of assembly and disassembly (where available).

Proposed materials: Stainless steel, Acrylic sheet (#2424 and #3232)
Material suppliers (respectively): Open, Acrylco

Proposed production processes: Vacuum forming, CNC milling of outer shade, milling stainless steel base.
Manufacturers: Domestic (Canada).

Proposed finishes: Gloss finish on shade, brushed finish on stem and base.

Proposed features: This line can be extended to include a hanging lamp, floor standing version and track lighting.
Optional technologies: "Touch-matic" base (when the stem or base are touched the lamp turns on or off).

Proposed production date: April 1, 2003

Unusual benefits of proposed product:

-Unique design will show innovative and progressive nature of company.
-Provide domestic jobs.
-As volumes increase alternative production processes can improve margin and balance of ecological and social issues.

Possible drawbacks of proposed product:

-Very low consideration of ecological issues (due to the high level of plastic waste from vacuum forming).
-Relatively high investment in set-up costs for the number of parts that are produced (vacuum forming and CNC milling).
-High labor costs of milling and forming outer shade.
-Must ensure recycled content on stainless steel is high and is accessible.
-Limited consistency.

Design Proposal

Material, process and artifact analysis:

Production stages:

		Standard · Eco-efficient · Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	*Actual (/10)*
a) Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	0
b) Work conditions:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
c) Material intensity:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
d) Energy intensity:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
e) Waste:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
g) Process toxicity:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
h) Monitoring levels:			
-During manufacturing of material:	Factor	X	2
-During manufacturing of product:	Factor	X	0
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	10

During artifact's use:

		Standard · Eco-efficient · Eco-effective (0 1 2 3 4 5 6 7 8 9 10 15 20)	
a)Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	2
b)Quality and durability level of product:	Factor	X	0
c)Degree of "product-pleasure":	Factor	X	8

During artifact's disposition:

		Standard · Eco-efficient · Eco-effective	
a)Difficulty of component disassembly:	Factor	X	0
b)Impact ecosystem during decay:	Factor	X	0
		Total:	**22** /21

EXECUTION LEVEL:	**FACTOR :**	**1**

Design Proposal

Date: November 15, 2002

Customer: XYZ Furniture Inc.

For Design Brief: #002
Proposal #2 (Production Version)

Product Name: "Slice Lamp"

Solutions to Primary objectives:

-Proposed retail: US$200

-Injection-molded corn based plastic would be used for the inner vertical tube and the colored glass shade (eco-effective). This process and the plastic are competitive with comparable plastics.

-Stainless steel stem and base are made from recycled stainless steel. This material is 5% higher in price than plated steel or anodized aluminum (however, it is more durable and has less ecological impact than the other two options throughout its life-cycle).

-It is produced at a ISO 14001 factory in Jiansu, China.

Solutions to Secondary objectives:

-There are only *two* materials in the lamp (not including wiring or the socket), and *four* primary parts (the socket and wiring, the outer and inner shade, the stem and the base. This decreases the complexity of assembly and disassembly (where available).

-The injection molding process eliminates virtually all plastic waste, and the off-cuts from the stainless steel are resold.

Proposed materials: Corn-based plastic NatureWorks, recycled stainless steel (#4 brushed finish), URL electrical parts.
Material suppliers (respectively): Cargill Dow LLC, open, open.

Proposed production processes: Injection molding plastic, automated cutting of stainless steel.
Manufacturers: China.

Proposed finishes: Gloss finish on shade, brushed finish on stem and base.

Proposed features: This line can be extended to include a hanging lamp, floor standing version and track lighting.
Optional technologies: "Touch-matic" base (when the stem or base are touched the lamp turns on or off).

Proposed production date: April 1, 2003

Unusual benefits of proposed product:

-Unique design will show innovative and progressive nature of company. The use of eco-effective materials will likely provide an exceptional marketing tool and draw in other environmentally conscious customers.

-Relatively high consideration and balance of economic, ecological and social issues (especially considering location of manufacturing and emphasis on economic issues).

-Simple production technique and reduction of parts will decrease labor costs and increase consistency.

Possible drawbacks of proposed product:

-Relatively high investment in set-up and tooling (injection molding die). It is critical to ensure that the die is of exceptionally high quality (to ensure the finished parts are attractive).

-Must ensure stainless steel is constantly being purchased from appropriate suppliers.

Material, process and artifact analysis:

Design Proposal

Production stages:

		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	Actual (/10)
a) Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	8
b) Work conditions:			
-During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	8
c) Material intensity:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	9
d) Energy intensity:			
-During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	8
e) Waste:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	9
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor	X	7
-During manufacturing of product:	Factor	X	8
g) Process toxicity:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	8
h) Monitoring levels:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	9
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	9

During artifact's use:

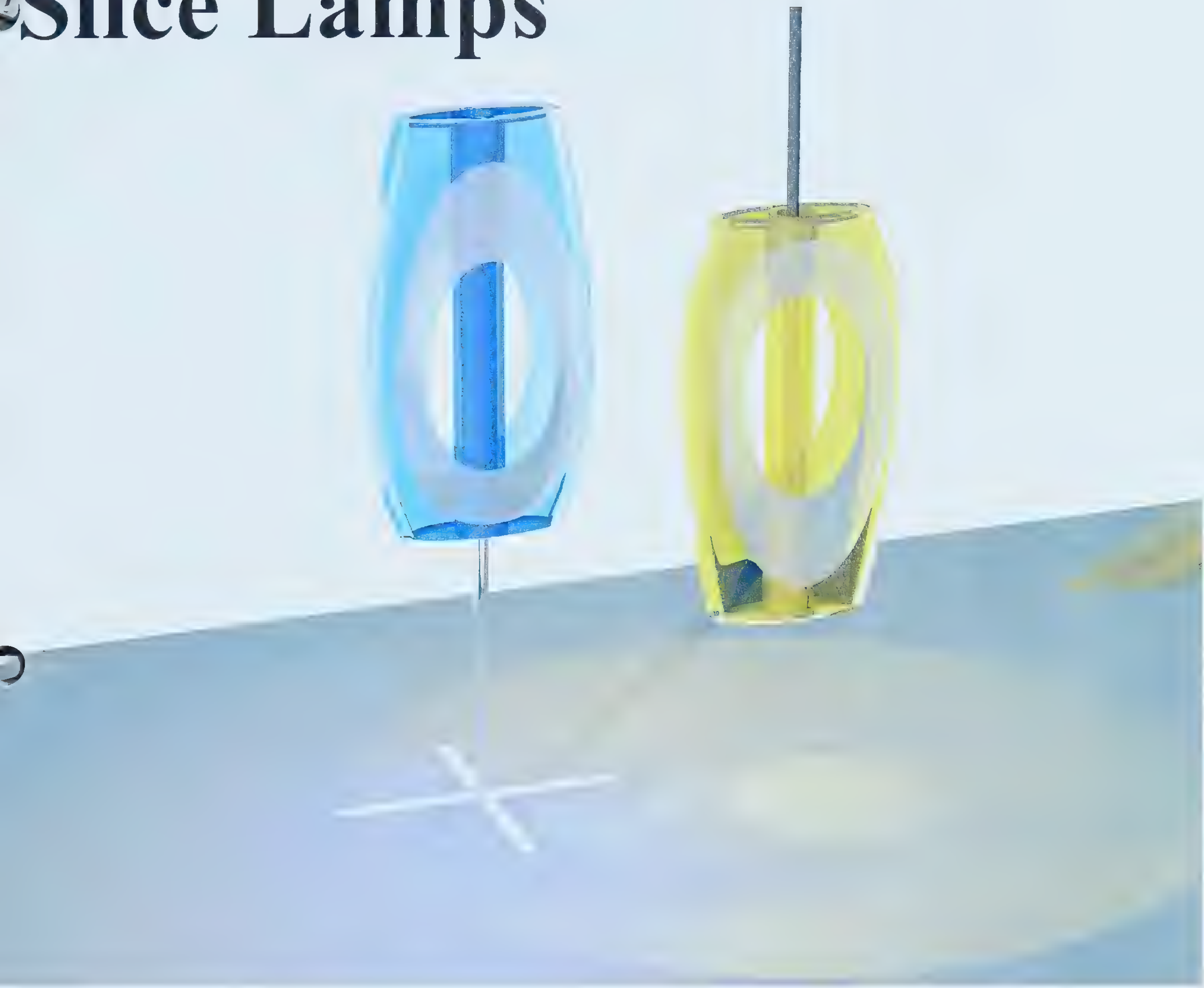
		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	
a)Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	10
b)Quality and durability level of product:	Factor	X	10
c)Degree of "product-pleasure":	Factor	X	10

During artifact's disposition:

		Standard / Eco-efficient / Eco-effective	
a)Difficulty of component disassembly:	Factor	X	9
b)Impact ecosystem during decay:	Factor	X	9
		Total:	**175** /21

EXECUTION LEVEL:	**FACTOR :**	**8**

Slice Lamps



Designer: Tim Antoniuk

	Depth	Width	Height
Hanging	3"	7"	11"
Table top	9"	9"	24"
Floor (not pictured)	12"	12"	60"

4.3 Design Brief #3 and Design Proposals

Design Brief

Date: November 15, 2002

Customer: XYZ Furniture Inc.

Design Brief #: 003

Category - Table series (Priority: Side tables, coffee table)

Primary objective(s):
Target customer - European, Japan, USA and Canadian - Customers with a new interest in the design industry
Target retailer - Design Within Reach (USA mail order), Loft (NYC), Sabu (Japan)
Target retail - US$300-400 (accent), $750-1000 (square coffee table)
Other - Intended for home, office settings
- Interested in unique materials that to appeal to this market
- Must be produced in a high quality and highly regulated factory (work conditions & waste)

Secondary objective(s): Reduction of parts and components
Environmentally sensitive materials and processes if possible

Customer demographics - 35-50years, mostly female, urban, $100,000+ income/household
Secondary customer - Interior design industry, film industry (promo)

Recommended materials: Aluminum, stainless steel, glass, plastic, wood, open -
Material Supplier (respectively): Open

Recommended production processes: Stamping, injection molding, high-efficiency CNC
Manufacturer: Europe, USA (ISO 14000 Chinese factories)

Required finishes: Low maintenance, non-rusting metals, low scratch wood/glass

Possible features: Open
Possible new technologies: Recycled plastics and aluminum

Key competition:
Low-end: Blu Dot (USA), Index (Europe)
High-end: Montis (Netherlands), B&B Italia (Italy), Idee (Japan)

Volume possibilities (annual): 2500 + units/sku

Desired due date - Production drawings: December 15, 2002
Desired due date - Prototypes: February 4, 2003
Scheduled production date: April 1, 2003

Unusual benefits of proposed product:
- Reduced production costs through careful selection of materials and efficient production processes
- Unique design to promote innovative qualities of company
- Gain market share through marketing unique and innovative materials (that are also environmentally sensitive)
- Easily produced due to accessible production processes
- Low investment in material and process research

Possible draw-backs of proposed product:
- Limited market size due to originality of design
- Limited ability to "collect" material (the product) after use (Note - possible marketing strategy to discount next purchase if used product is returned to selling agent)

Design Brief

Material, process and artifact analysis:

Production stages:

		Standard · Eco-efficient · Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	Actual (/10)
a) Proposed materials: -Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	2
b) Work conditions:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	8
c) Material intensity:			
-During manufacturing of material:	Factor	X	4
-During manufacturing of product:	Factor	X	2
d) Energy intensity:			
-During manufacturing of material:	Factor	X	2
-During manufacturing of product:	Factor	X	2
e) Waste:			
-During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	6
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor	X	4
-During manufacturing of product:	Factor	X	6
g) Process toxicity:			
-During manufacturing of material:	Factor	X	4
-During manufacturing of product:	Factor	X	4
h) Monitoring levels:			
-During manufacturing of material:	Factor	X	4
-During manufacturing of product:	Factor	X	4
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	6

During artifact's use:

		Standard · Eco-efficient · Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	
a)Proposed materials: -Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	8
b)Quality and durability level of product:	Factor	X	6
c)Degree of "product-pleasure":	Factor	X	10

During artifact's disposition:

		Standard · Eco-efficient · Eco-effective	
a)Difficulty of component disassembly:	Factor	X	10
b)Impact ecosystem during decay:	Factor	X	2
		Total:	108 /21

EXPECTATION LEVEL:	FACTOR :	5

Date: November 15, 2002

Design Proposal

Customer: XYZ Furniture Inc.

For Design Brief: #003
Proposal #1 (Prototype/Batch production)

Product Name: "Bone Tables"

Solutions to Primary objectives:

-Proposed retail: US$350 (accent), $750 (square coffee).
-Laser cut steel (12 gauge) cut and welded into shape - appears to be cast (high perceived quality).
-Laser cut parts enable very high tolerance "nestling" of parts to reduce waste to 10%-15%.
-The welded table could be finished and coated with a "clear coat" (lacquer) to appear like stainless steel, or powder coated (virtually any color and texture).
-Produced in a domestic factory (Europe, USA or Canada) to assure high quality, consistency and ethical work conditions.

Solutions to Secondary objectives:

-There are *three* different shaped metal parts per table and one top. This decreases inventory levels and the complexity of manufacturing parts during the fabrication stage.
-Low grade, mild steel is used (can be in a closed loop cycle), but limited in eco-effectiveness because coating must be removed (acid or burned off).
-Wooden top is made from recycled MDF (medium density fiber board), and veneered with domestically grown and farmed veneer.

Proposed materials: Cold-rolled steel, powder coat, MDF core walnut veneer.
Material suppliers (respectively): Open, Tiger-Drylac, Formica Ligna.

Proposed production processes: Laser cutting, Mig welding, powder coating, wood CNC cutting, lacquer.
Manufacturers: (Depends on production volume and location of sales) Domestic: Europe and Canada.

Proposed finishes: Powder coat, clear lacquer on wood.

Proposed features: Extensive line of tables (3 sizes of accent tables, 2 sizes of coffee tables, console, 3 sizes of dining tables and desks).
Optional technologies: Robotic welding and finishing to reduce worker fatigue, metal stamping of metal (all require sales of 500 units per year but dramatically improve consistency and margin).

Proposed production date: April 1, 2003

Unusual benefits of proposed product:

-Unique design may draw in many different markets and demographics.
-Simple production technique would allow production of items in each country it is sold in (this could aid in avoiding import taxes and decreasing transportation charges).
-Very low investment in set-up and tooling.
-Production technique allows for improvements as production volumes go up (each change in technique reduces: energy intensity, complexity of manufacturing, and work conditions.

Possible drawbacks of proposed product:

-Limited balance of ecological issues (related to the disposal and decay stages).
-Limited balance of social issues (related to material and process toxicity in the work environment).

Material, process and artifact analysis:

Design Proposal

Production stages:

		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	Actual (/10)
a) Proposed materials: -Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	2
b) Work conditions: -During manufacturing of material:	Factor	X	2
-During manufacturing of product:	Factor	X	6
c) Material intensity: -During manufacturing of material:	Factor	X	4
-During manufacturing of product:	Factor	X	3
d) Energy intensity: -During manufacturing of material:	Factor	X	1
-During manufacturing of product:	Factor	X	1
e) Waste: -During manufacturing of material:	Factor	X	4
-During manufacturing of product:	Factor	X	3
f) Complexity of manufacturing: -During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	9
g) Process toxicity: -During manufacturing of material:	Factor	X	3
-During manufacturing of product:	Factor	X	1
h) Monitoring levels: -During manufacturing of material:	Factor	X	6
-During manufacturing of product:	Factor	X	4
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	10

During artifact's use:

		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10 15 20)	
a)Proposed materials: -Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	4
b)Quality and durability level of product:	Factor	X	4
c)Degree of "product-pleasure":	Factor	X	10

During artifact's disposition:

		Standard / Eco-efficient / Eco-effective	
a)Difficulty of component disassembly:	Factor	X	2
b)Impact ecosystem during decay:	Factor	X	0
		Total:	**85** /21

EXECUTION LEVEL:	**FACTOR :**	**4**

Design Proposal

Date: November 15, 2002

Customer: XYZ Furniture Inc.

For Design Brief: #003
Proposal #2 (Production)

Product Name: "Bone Tables"

Solutions to Primary objectives:

-Proposed retail: US$350 (accent), $750 (square coffee).
-Progressive stamping of aluminum parts into 3D shape – this process allows the tables to appear to be cast (high perceived quality).
-Aluminum waste is reduced to 10%-15%. It is recyclable and would be sold (closed loop).
-Produced in a domestic factory (Europe, USA or Canada) to assure high quality, consistency and ethical work conditions.

Solutions to Secondary objectives:

-There are *two* different shaped metal parts per table and one top. This decreases inventory levels and the complexity of manufacturing parts during the fabrication stage.
-Disassembly of the products parts is extremely easy – Lacquer is easily removed with non-toxic stripper. There are two materials: aluminum and solid compressed wood that is coated with wax.
-Labor, and toxic fumes are dramatically reduced through a massive reduction of welded seams (the most toxic part of this entire process).
-The welded table could be finished and coated with a "clear coat" with an environmentally benign lacquer.

Proposed materials: Brushed aluminum, compressed wood, lacquer, oil and wax
Material suppliers (respectively): Open, Ligna, Bio-Shield

Proposed production processes: Progressive-die stamping, CNC wood milling, oil and wax coating.
Manufacturers: Domestic: Europe and Canada.

Proposed finishes: Brushed aluminum with clear or tinted lacquer, natural finish on wood tops.

Proposed features: Extensive line of tables (3 sizes of accent tables, 2 sizes of coffee tables, console, 3 sizes of dining tables and desks). Light weight.
Optional technologies: Robotic welding and finishing of stamped parts to reduce worker fatigue. Recycled glass tops, or recycled polyester honeycomb (antimony free).

Proposed production date: April 1, 2003

Unusual benefits of proposed product:

-Unique design may draw in many different markets and demographics.
-Simple production technique would allow production of items in each country it is sold in (this could aid in avoiding import taxes and decreasing transportation charges).
-Relatively low investment in set-up and tooling for proposed production volumes.
-Dramatic reduction in: energy intensity, complexity of manufacturing, process and material toxicity, unusable waste, and an improvement in work conditions (of comparable products).

Possible drawbacks of proposed product:

-Must ensure that aluminum is not virgin material and that specified lacquer is used.

Material, process and artifact analysis:

Design Proposal

		Standard 0 1 2 3 / Eco-efficient 4 5 6 7 8 9 / Eco-effective 10 +	Actual (/10)
Production stages:			
a) Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	8
b) Work conditions:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	9
c) Material intensity:			
-During manufacturing of material:	Factor	X	9
-During manufacturing of product:	Factor	X	8
d) Energy intensity:			
-During manufacturing of material:	Factor	X	7
-During manufacturing of product:	Factor	X	8
e) Waste:			
-During manufacturing of material:	Factor	X	9
-During manufacturing of product:	Factor	X	9
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	9
g) Process toxicity:			
-During manufacturing of material:	Factor	X	4
-During manufacturing of product:	Factor	X	8
h) Monitoring levels:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	8
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	8
During artifact's use:			
a)Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	10
b)Quality and durability level of product:	Factor	X	10
c)Degree of "product-pleasure":	Factor	X	10
During artifact's disposition:		Standard / Eco-efficient / Eco-effective	
a)Difficulty of component disassembly:	Factor	X	8
b)Impact ecosystem during decay:	Factor	X	10
		Total:	**176** /21
EXECUTION LEVEL:		**FACTOR :**	**8**

Bone Table

Designer: Tim Antoniuk

Depth	Width	Height
20"	20"	20"

4.4 Design Brief #4 and Design Proposals

Design Brief

Date: November 15, 2002

Customer: XYZ Furniture Inc.

Design Brief #: 004

Category - "Bar" stool

Primary objective(s):
Target Customer - European, Japan, USA and Canadian design conscious market (contemporary) who are familiar with leading design companies and brand names
Target Retailer - Design Within Reach (USA mail order), Modern Living (NYC), Sabu (Japan)
Target Retail - US$400-600 (mid to upper end)
Other - Intended for home and bar settings.
- Attention and focus on form, but consider Eco-Efficient and Eco-Effective materials
- Decrease material intensity and waste

Secondary objective(s): Reduction of parts and components
Highly durable

Customer demographics - 35-50years, male and female, urban, $100,000+ income/household
Secondary customer - Interior design industry, film industry

Recommended materials: Aluminum, steel, plastic, fabrics, open
Material supplier (respectively): DesignTex, Kvadrat (upholstery), TerraTex polyesters

Recommended production processes: Stamping, injection molding, high-efficiency CNC, antimony free polyesters
Manufacturer: Europe, USA (ISO 14000 Chinese factories)

Required finishes: Low maintenance, non-rusting metals, high durability and easy to clean fabrics

Possible features: Open
Possible new technologies: Recycled plastics and aluminum and steel, high quality post-consumer materials.

Key competition:
Low-end: Blu Dot (USA), Index (Europe), Pure Design & Hothouse (Canada)
High-end: Ligne Roset (France), B&B Italia (Italy), Idee (Japan)

Volume possibilities (annual): 10,000 + units/sku/year

Desired due date - Production drawings: December 15, 2002
Desired due date - Prototypes: February 4, 2003
Scheduled production date: April 1, 2003

Unusual benefits of potential product:
- Reduced production costs through careful selection of materials and efficient production processes
- Unique design to promote innovative qualities of company
- Gain market share through marketing unique and innovative materials
- Promote product through ethical work conditions, reduced waste, and eco-efficient materials

Possible draw-backs of proposed product:
- Limited market size due to originality of design
- Limited ability to "collect" material (the product) after use (Note - possible marketing strategy to discount next purchase if used product is returned to selling agent)

Design Brief

Material, process and artifact analysis:

		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	Actual (/10)
Production stages:			
a) Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor		8
b) Work conditions:			
-During manufacturing of material:	Factor		4
-During manufacturing of product:	Factor		2
c) Material intensity:			
-During manufacturing of material:	Factor		6
-During manufacturing of product:	Factor		10
d) Energy intensity:			
-During manufacturing of material:	Factor		4
-During manufacturing of product:	Factor		4
e) Waste:			
-During manufacturing of material:	Factor		10
-During manufacturing of product:	Factor		10
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor		6
-During manufacturing of product:	Factor		5
g) Process toxicity:			
-During manufacturing of material:	Factor		8
-During manufacturing of product:	Factor		8
h) Monitoring levels:			
-During manufacturing of material:	Factor		8
-During manufacturing of product:	Factor		8
i) Design for improvements (and for varying production levels) over the life of the product:	Factor		4
During artifact's use:		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	
a)Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor		8
b)Quality and durability level of product:	Factor		10
c)Degree of "product-pleasure":	Factor		10
During artifact's disposition:		Standard / Eco-efficient / Eco-effective	
a)Difficulty of component disassembly:	Factor		6
b)Impact ecosystem during decay:	Factor		8
		Total:	147 21

EXPECTATION LEVEL:	**FACTOR :**	**7**

Date: November 15, 2002

Design Proposal

Customer: XYZ Furniture Inc.

For Design Brief: #004
Proposal #1 (Prototype/Batch production)

Product Name: "Sip Stool"

Solutions to Primary objectives:
- -Proposed retail: US$400
- -Polyester resin that does not have antimony in it would be used (to *reduce* material, process and disposal/decay toxicity).
- -Foam and fabric are eco-effective and eco-efficient (respectively).
- -Produced in a domestic factory (Europe, USA or Canada) to assure high quality, consistency and ethical work conditions.

Solutions to Secondary objectives:
- -There is only *one* part that makes up the entire "shell" of the stool, and a recycled MDF base for the foam and fabric to be attached to (*four* parts and materials in total). This decreases the complexity of assembly and disassembly (where available).
- -The tinted resin (polyester) will prevent any color from wearing off (unlike most coating processes).
- -The fabric and foam are "long wearing" high quality commercial and residential grade.

Proposed materials: Polyester resin and fiberglass, viscoelastic "memory" foam (50% vegetable matter), MDF, 100% wool fabric.
Material suppliers (respectively): Open, Carpenter, open, Kvadrat.

Proposed production processes: -Entire "shell" (including foot rest) is produced with a fiberglass chop gun shot into a two-part mold process.
Manufacturers: (Depends on production volume and location of sales) Domestic: Europe and Canada.

Proposed finishes: Egg shell finish to hide scratches and wear.

Proposed features: Two heights (30" and 24")
Optional technologies: Spun metal base with cast steel foot rests and fiberglass upper-body.

Proposed production date: April 1, 2003

Unusual benefits of proposed product:
- -Unique design will show innovative nature of company.
- -As volumes increase alternative production processes can improve margin and balance of ecological and social issues.
- -Simple production technique would allow production of items in each country it is sold in (this could aid in avoiding import taxes and decreasing transportation charges).
- -Very low investment in set-up and tooling.
- -Production technique allows for improvements as production volumes go up (each change in technique reduces: energy intensity, complexity of manufacturing, and work conditions.

Possible drawbacks of proposed product:
- -Very limited balance of ecological issues (related to fiberglassing process during manufacturing and during the disposal and decay stages of the product).
- -Limited balance of social issues (related to material and process toxicity in the work environment).

Design Proposal

Material, process and artifact analysis:

Production stages:

		Standard · Eco-efficient · Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	Actual (/10)
a) Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	0
b) Work conditions:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
c) Material intensity:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
d) Energy intensity:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	3
e) Waste:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	2
g) Process toxicity:			
-During manufacturing of material:	Factor	X	0
-During manufacturing of product:	Factor	X	0
h) Monitoring levels:			
-During manufacturing of material:	Factor	X	2
-During manufacturing of product:	Factor	X	0
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	10

During artifact's use:

		Standard · Eco-efficient · Eco-effective (0 1 2 3 4 5 6 7 8 9 10 15 20)	
a)Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	2
b)Quality and durability level of product:	Factor	X	2
c)Degree of "product-pleasure":	Factor	X	10

During artifact's disposition:

		Standard · Eco-efficient · Eco-effective	
a)Difficulty of component disassembly:	Factor	X	2
b)Impact ecosystem during decay:	Factor	X	0
		Total:	**30** /21

EXECUTION LEVEL:	FACTOR :	1

Design Proposal

Date: November 15, 2002

Customer: XYZ Furniture Inc.

For Design Brief: #004
Proposal #2 (Production Version)

Product Name: “Sip Stool”

Solutions to Primary objectives:

-Proposed retail: US$400
-Roto-molded corn based plastic would be used as a replacement for polyester resins (eco-effective).
-Foam and fabric are eco-effective and eco-efficient (respectively).
-Produced in a domestic factory (Europe, USA or Canada) to assure high quality, consistency and ethical work conditions.

Solutions to Secondary objectives:

-There is only *one* part that makes up the entire “shell” of the stool, and a recycled MDF base for the foam and fabric to be attached to (*four* parts and materials in total). This decreases the complexity of assembly and disassembly (where available).
-The tinted plastic (natural dies in the plastic) will prevent any color from wearing off (unlike most coating processes).
-The fabric and foam are “long wearing” high quality commercial and residential grade.

Proposed materials: Corn-based plastic (hemp reinforced if necessary) Natureworks PLA, viscoelastic “memory” foam (50% vegetable matter), MDF, 100% wool fabric.
Material suppliers (respectively): Cargill DowLLC, Carpenter, open, Kvadrat.

Proposed production processes: Roto-molded plastic.
Manufacturers: (Depends on production volume and location of sales) Domestic: Europe and USA.

Proposed finishes: Egg shell finish to hide scratches and wear.

Proposed features: Two heights (30” and 24”)
Optional technologies: Spun metal base with cast steel foot rests, attached to plastic upper “shell” (incase base durability is an issue).

Proposed production date: April 1, 2003

Unusual benefits of proposed product:

-Unique design will show innovative and progressive nature of company (sell to environmentally conscious customers).
-Very high consideration and balance of economic, ecological and social issues.
-Simple production technique and reduction of parts will decrease labor costs and increase consistency.

Possible drawbacks of proposed product:

-Relatively high investment in set-up and tooling (mold for roto-molding).

Design Proposal

Material, process and artifact analysis:

Production stages:

		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	*Actual (/10)*
a) Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	10
b) Work conditions:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	10
c) Material intensity:			
-During manufacturing of material:	Factor	X	10
-During manufacturing of product:	Factor	X	10
d) Energy intensity:			
-During manufacturing of material:	Factor	X	7
-During manufacturing of product:	Factor	X	8
e) Waste:			
-During manufacturing of material:	Factor	X	9
-During manufacturing of product:	Factor	X	10
f) Complexity of manufacturing:			
-During manufacturing of material:	Factor	X	8
-During manufacturing of product:	Factor	X	9
g) Process toxicity:			
-During manufacturing of material:	Factor	X	10
-During manufacturing of product:	Factor	X	10
h) Monitoring levels:			
-During manufacturing of material:	Factor	X	10
-During manufacturing of product:	Factor	X	10
i) Design for improvements (and for varying production levels) over the life of the product:	Factor	X	10

During artifact's use:

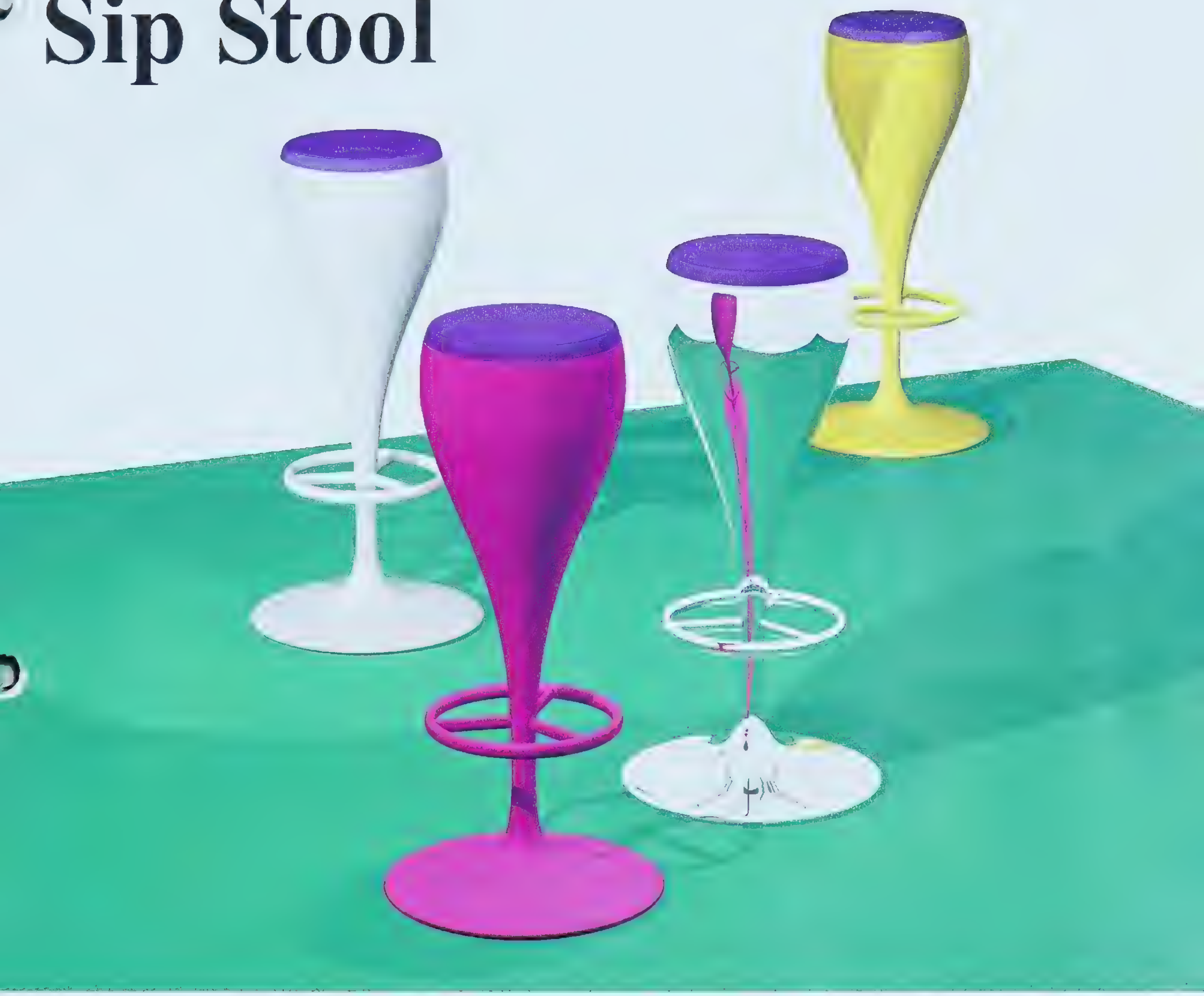
		Standard / Eco-efficient / Eco-effective (0 1 2 3 4 5 6 7 8 9 10+)	
a)Proposed materials:			
-Toxicity levels, bio-accumulative, off-gassing, etc.:	Factor	X	10
b)Quality and durability level of product:	Factor	X	10
c)Degree of "product-pleasure":	Factor	X	10

During artifact's disposition:

		Standard / Eco-efficient / Eco-effective	
a)Difficulty of component disassembly:	Factor	X	10
b)Impact ecosystem during decay:	Factor	X	10
		Total:	**199** /21

EXECUTION LEVEL:	**FACTOR :**	**9.5**

Sip Stool



Designer: Tim Antoniuk

Depth	Width	Height
18"	18"	24"
18"	**18"**	**30"**

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7. Appendixes

Case Study # 1 - *"Ford Motors"*

There are few companies or people that have had as much impact on world's economy as The Ford Motor Company. Materials and processes evolved as a result of this companies extensive research and development program. Consumer spending and purchasing patterns were altered as affordable goods, such as cars, became available to a growing middle class sector that Henry Ford helped to develop. During the next century his great-grand son and current chairman, William Clay Ford, Jr., hopes to broaden the companies focus by reducing the direct and indirect impact that it has on social and ecological issues. The following are excerpts taken from McDonough and Braungart's book, *Cradle to Cradle*.

> In May 1999, William Clay Ford, Jr.,...made a dramatic announcement: Ford's massive River Rouge factory in Dearborn, Michigan, an icon of the first Industrial Revolution, would undergo a $2 billion makeover to transform it into an icon of the next.
>
> Henry Ford had bought the property when it was a marsh, and by the mid-1920s the plant began producing cars. In the following decades the River Rouge manufacturing plant grew to become one of the largest industrial complexes on the planet, fulfilling Ford's vision of a sprawling, vertically integrated facility capable of producing an automobile from start to finish.
>
> By the end of the century, the facilities were showing their age. Although Ford's Mustang was still made there, the ranks of employees had dwindled to under seven thousand (nearly 100,000)...Decades' worth of manufacturing processes had taken a toll on the soil and water.
>
> Ford Motor Company easily could have decided to do as their competitors had done – to close down the site, put a fence around it, and erect a new plant in a site where land was clean, cheap, and easily developed. Instead, it was committed to keeping a manufacturing operation going at the Rouge. In 1999 William Clay Ford, Jr., in his new post as chairman, took the commitment a step further. He looked at the rusting pipes and mounds of debris and took on the challenge (and responsibility) of restoring it to a living environment.
>
> The first step was to (collect) representatives of all sectors of the company, along with outsiders like chemists, toxicologists, biologists, regulatory specialists, and union representatives...Their primary agenda was to create a set of goals, strategies, and ways of measuring progress...and encourage them to raise the difficult questions.
>
> The company's commitment to financial security had been forged in the fire. Henry Ford had narrowly skirted bankruptcy during WW II, and seriously struggled to get the company back on its feet. Ever since then the bottom line has been a solid focus for everything the company does – every innovation must be good for profits. *But* the team had complete freedom to explore innovative ways of creating shareholder value.
>
> Ford's design team said, "Let's assume the worst." When it found that there was indeed contamination at several of its plant sites, Ford negotiated with the government

to experiment with treating its soil in a new way…It has been exploring innovative cleanup methods such as phytoremediation, a process that uses green plants to remove toxins from soil, and mycoremediation, or cleaning soil with mushrooms and fungi…The health of the site is measured not in terms of meeting minimum governments-imposed standards but with respect to things like the number of earth-worms per cubic foot, the diversity of birds and insects on the land and of the aquatic species in a nearby river, and the attractiveness of the site to local residents. The work is governed by a compelling goal: creating a factory site where Ford employees' own children could play safely.

As the company looked at its new sustainability manufacturing agenda, it found more and more opportunities to improve environmental performance without conflicting with financial objectives, and these successes justified taking on more ambitious environmental challenges.

The redesign of the manufacturing facility embodies the company's commitment to social equality as well as to ecology and the economic bottom line. (McDonough, Braungart 157 - 163)

Case Study # 2 - *"InterFace – Pipes"*

Paul Hawken, Amory Lovins and L. Hunter Lovins in their book *Natural Capitalism,* outline a case study that highlights the engineering and critical thinking achievements of a mechanical engineer is described in some detail. This is a summary of Eng Lock Lee's efforts and influence.

> In 1997, leading American carpet maker Interface was building a factory in Shanghai. One of its industrial processes required 14 pumps. In optimizing the design, the top Western specialist firm sized those pumps to total 95 horsepower. But a fresh look by Interface/Holland's engineer Jan Schilham, applying methods learned from Singaporean efficiency expert Eng Lock Lee, cut the design's pumping power to only 7 horse power – a 92 percent or 12-fold energy savings – while reducing its capital cost and improving a multitude of other area. (116) Eng Lock Lee – was trained in the same engineering principles as everyone else. He buys hardware from the same companies and looks up data in the same handbooks. Yet his designs are typically about three to ten times more efficient, delivering better services, and cost less to build. The trick is all in how he *thinks*. (123)

<u>Case Study # 3 - *"InterFace – Disposal"*</u>

In the late 90's, InterFace, an Atlanta based carpet manufacturer, began to investigate and implement a new strategic plan for the entire company. It would fundamentally alter want it sold and how it did so. The following excerpts come from Paul Hawken, Amory Lovins and L. Hunter Lovins' *Natural Capitalism.*

> Traditionally, old-fashioned broadloom carpet is replaced every decade because it develops worn spots. An office must be shut down, furniture removed, carpet torn up and sent to land fill, new carpet laid down, the office restored, operations resumed, and workers perhaps exposed to carpet-glue fumes. It takes two pounds of fossil fuel to turn one pound of mainly petroleum based feedstock into carpet, plus an additional amount to transport it to the customer and back to the landfill, where it resides for the next 20,000 years or so. It is incredible, but over 5 billion pounds of the carpet in landfills has Interface's name on it. Chairman Ray Anderson realized that not throwing more energy and money into holes in the ground represents a major business opportunity.
>
> Interface therefore launched a transition from selling carpet to leasing floor-covering services. People want to walk on and look at carpet, not own it. They can obtain those services at much lower cost if Interface owns the carpet and remains responsible for keeping it clean and fresh in return for a monthly fee under the companies Evergreen Lease. Whenever indicated by monthly inspections, Interface replaces over-night the 10-20 percent of the carpet tiles that show 80-90 percent of the wear. This reduces the amount of carpet material required by about 80 percent because the worn part of the carpet is left in place. It also provides better service at reduced life-cycle cost, increases net employment (less manufacturing but more upkeep), and eliminates disruption, since worn tiles are seldom under furniture. Because the carpet is laid in the form of tiles, glue fumes are also significantly reduced or possibly eliminated. The customer's former capital investment becomes a lease expense.
>
> So far so good: a Factor Five savings in materials, plus considerable energy and money savings. But Interface's latest technical innovation goes much further in turning waste into savings. Other manufacturers are starting to "down-cycle" nylon and PVC-based carpet into a lower quality use – backing – thus losing the embodied energy value of the nylon. Interface has instead made a novel polymeric material into a new kind of floor-covering service, called Solenium, that can be completely remanufactured back into itself. All worn materials can and will be completely separated into their components, fiber and backing, and each component remade into an identical fresh product. The production process is simpler and less wasteful: Manufacturing the upper surface produces 99.7 percent less waste than making normal carpet, and the other 0.3 percent gets reused. The new product also provides markedly better service. It's highly stain-resistant, and does not mildew. It is easily cleaned with water, is 35 percent less materials-intensive, and yet four times as durable, so it uses sevenfold less massflow per unit of service…It also comes installed, maintained, and reclaimed under a service lease. Compared with standard nylon broadloom carpet, Solenium's *combination* of improved physical attributes (Factor Seven less massflow from dematerialization and greater durability) *and* the service lease (a further Factor Five massflow from replacing only the worn parts) multiplies to a reduction in the net flow of materials and embodied energy by 97 percent – Factor 31. Manufacturing cost is also substantially reduced and margin increased. Its net climate impact is zero. (Hawken, et al. 139 - 141)

Case Study # 4 - *"Rohner Fabrics"*

In the book *Cradle to Cradle*, McDonough and Braungart provide a case study of a fabric mill in Switzerland highlights how a company on the verge of insolvency was able to transform itself to become an economic, ecological and socially responsible manufacturer through reassessing how and where profits can be made. The following information comes from parts of this story.

> In the early 1990s the two of us (William McDonough and Michael Braungart) were asked by DesignTex, a division of Steelcase, to conceive and create a compostable upholstery fabric, working with the Swiss textile mill Rohner. We were asked to focus on creating an aesthetically unique fabric that was also environmentally intelligent. DesignTex first proposed that we consider cotton combined with PET (polyethylene terephthalate) fibers from recycled soda bottles. What could be better for the environment, they thought, than a product that combined "natural" material with a "recycled" one? Such a hybrid material had the additional apparent advantage of being readily available, market-tested, durable, and cheap. (105 – 106)
>
> But when we looked carefully at the potential long-term design legacy, we discovered some disturbing facts. First, as we have mentioned, upholstery abrades during normal use, and so our design had to allow for the possibility that particles might be inhaled or swallowed. PET is covered with synthetic dyes and chemicals and contain other questionable substances – not exactly what you want to breathe or eat. Furthermore, the fabric would not be able to continue after its useful life as either a technical or biological nutrient. The PET would not go back into the soil safely, and the cotton could not be circulated in industrial cycles…This was not a product worth making. (106)
>
> The team decided to design a fabric that would be safe enough to eat: it would not harm people who breathed it in, and it would not harm natural systems after its disposal. In fact, as a biological nutrient, it would nourish nature. (106 – 107)
>
> The textile mill that was chosen to produce the fabric was quite clean by accepted environmental standards, one of the best in Europe, yet it had an interesting dilemma. Although the mill's director, Albin Kaelin, had been diligent about reducing levels of dangerous emissions, government regulators had recently defined the mill's fabric trimmings as hazardous waste. The director had been told that he could no longer bury or burn these trimmings in hazardous-waste incinerators in Switzerland but had to export them to Spain for disposal. (Note the paradoxes here: the trimmings of a fabric are not to be buried or disposed of without expensive precaution, or must be exported "safely" to another location, but the material itself can still be sold as safe for installation in an office or home.) (107)
>
> The mill interviewed people living in wheel chairs and discovered that their most important needs in seating fabrics were that it be strong and that it "breathe." The team decided on a mixture of safe, pesticide-free plant and animal fibers for the fabric…Then we began working on the most difficult aspect of the design: the finishes, dyes, and other process chemicals. Instead of filtering out mutagens, carcinogens, endocrine disrupters, persistent toxins, and bioaccumulative substances at the end of the process, we would filter them out at the beginning. (107 – 108)

Sixty chemical companies declined the invitation to join the project, uncomfortable at the idea of exposing their chemistry to the kind of scrutiny it would require. Finally one European company agreed to join. With its help, we eliminated from consideration almost eight thousand chemicals that are commonly used in the textile industry...We ended up selecting only thirty-eight of them from which we created the entire fabric line. What might seem like an expensive and laborious research process turned out to solve multiple problems and to contribute to a higher-quality product that was ultimately more economical. (108)

The fabric went into production. The factory director later told us that when regulators came on their rounds and tested the effluent (the water coming our of the factory), they thought their instruments were broken. They could not identify any pollutants, not even elements they knew were in the water when it came into the factory. To confirm their testing equipment was actually in working order, they checked the influent for the town's water mains. The equipment was fine: it was simple that by most parameters the water coming out of the factory was as clean – or even cleaner than – the water going in. When a factory's effluent is cleaner than its influent, it might well prefer to use its effluent as influent. (108 – 109)

The process had additional positive side effects...Regulatory paper work was eliminated. Workers stopped wearing the gloves and masks that had given them a thin veil of protection against workplace toxins. The mill's products became so successful that it faced a new problem: financial success, just the kind of problem businesses want to have. (109)

Date 02 .28 .03

Title "TIMANTON"

THIS CD CONTAINS CONCEPT RENDERINGS AND PICTURES OF PRODUCTS THAT WERE EXHIBITED AT THE F.A.B. GALLERY IN FEBRUARY. 2003.

-TIM ANTONIUK